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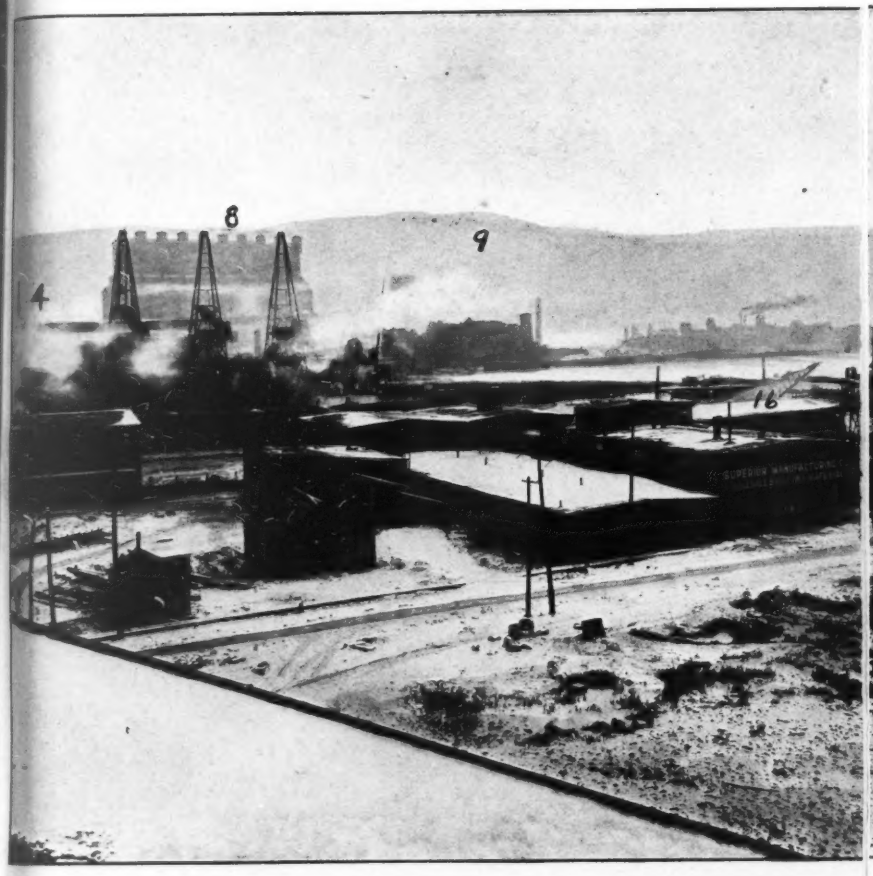
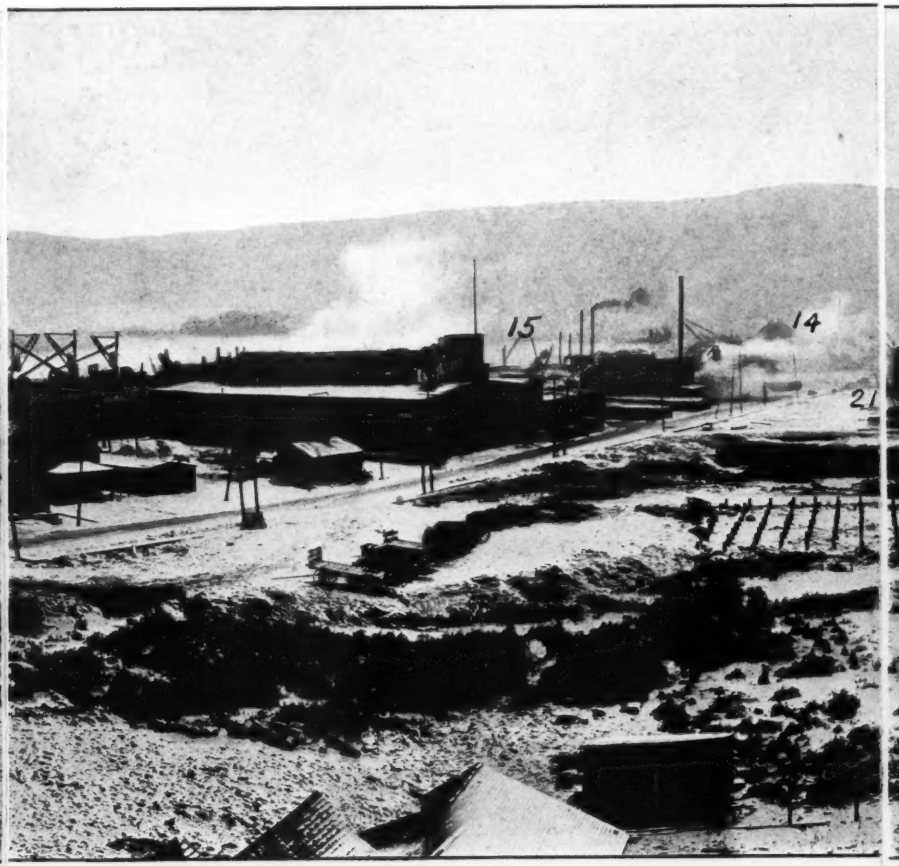
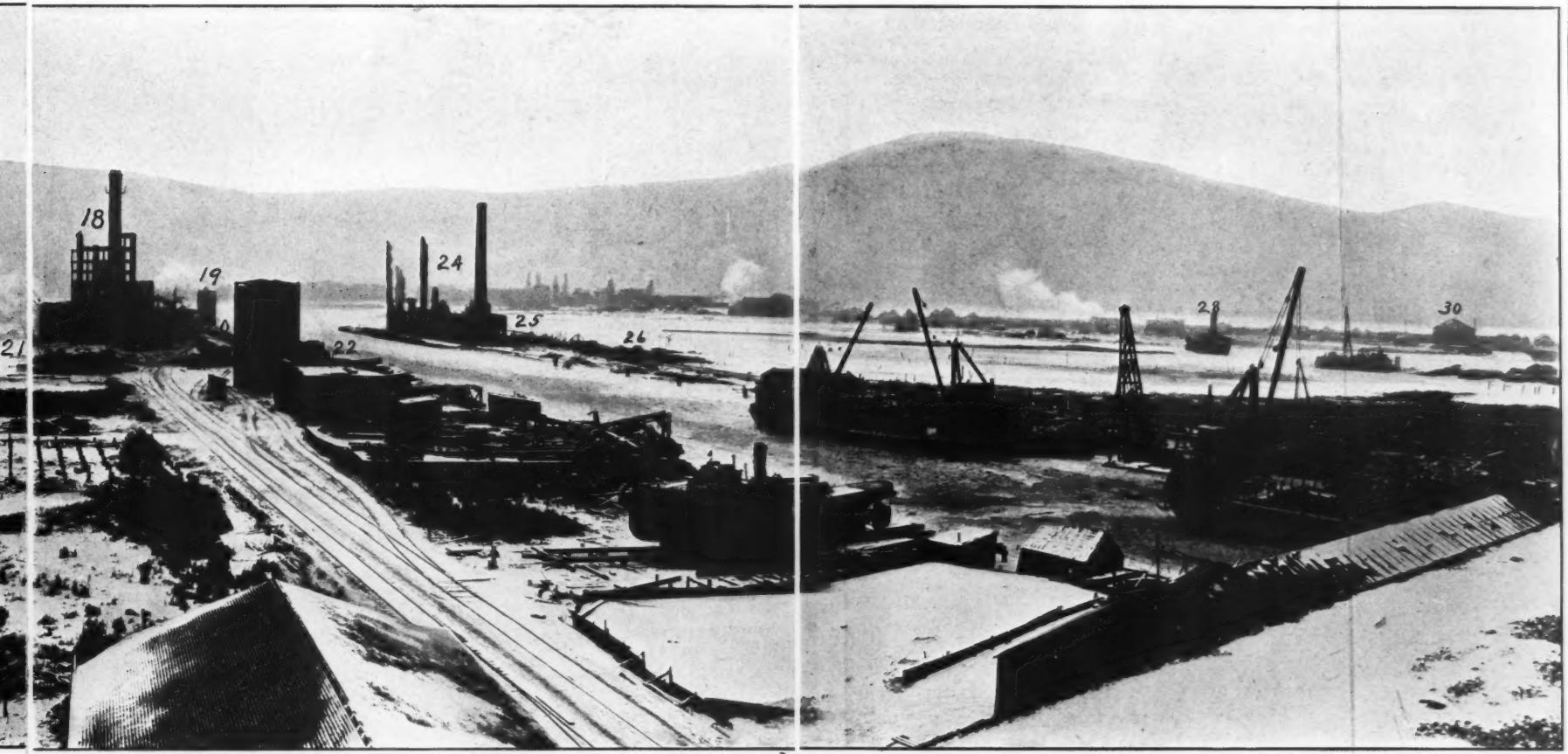




Panoramic View of the Burned District. Numbers c

No. 4. Great Northern Elevator "A."
No. 8. Great Northern Elevator "S."
No. 9. Globe Elevator No. 1.
No. 14. Great Lakes Dock & Dredge Co.
Nos. 15 and 16. Superior Manufacturing Co.
No. 18. Duluth-Superior Storage Company.
No. 19. Grand Republic Elevator.
No. 20. Minkota Flour Mill.

Superior, Wis
Fire of Nov. 8,



nbers on View Correspond with Numbers on Map.

, Wisconsin.
lov. 8, 1907.

No. 21. Minkota Elevator.
No. 22. Ruins of Commander Flour Mill.
No. 24. Freeman Flour Mill.
No. 25. Freeman Warehouse.
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Stocks and Preparing Machinery of Certain Textile Mills and Their Hazards.

The purpose of this article is to describe briefly, without going into complete detail, the machinery used in preparing processes of certain textile and similar industries and to give an account of the accompanying hazard.

The information is obtained almost entirely from mills located in the Middle Eastern States. Much of the machinery, however, would be found in mills of certain classes in New England and possibly in other portions of the country. It is not the intention to discuss the machinery of high-grade worsted and straight cotton mills. The class of mills treated are rather those working wool, cotton, mixed, and waste stock on woolen or waste machinery.

STOCK.

As the class of stock worked in a mill is an important feature in determining the comparative hazard, a broad classification of stocks is desirable. The main distinction is between animal and vegetable stocks. The animal stocks are practically non-hazardous in preparation. Furthermore, a large number of fires in preparing machinery are due to friction. Friction causes a rise in temperature and upon reaching a certain degree combustion takes place in vegetable matter (depending on the quality), where the wool fibre will only melt and not burn.

Wool is graded according to the length and fineness of the "staple" or fibre. The best grade, long fibre wool is four inches to twelve inches in length and is obtained from full-blooded or well-bred sheep and is classed as "full-blooded wool."

Cotton fibres vary in length and fineness and when spun alone into cotton yarn are usually worked in a straight cotton mill. The preparing machinery of this class of mill, such as pickers, lappers, cotton cards, etc., has already been described in a previous issue of the Special Hazards Bulletin.

Wool stock of shorter staple and coarser quality is worked on machinery of a different class known as "woolen" machinery. The product is lower grade and other stocks are usually mixed with the wool. Consequently there is a class of mill known variously as the "woolen mill," the "mixed woolen mill" or the "mixed mill."

The same type of preparing machinery, but generally lower grade stocks, is found in other classes. One is the mill making carpet yarn where wool and hair of various grades, cotton, different waste stocks, and frequently jute, are found. Another is known in New York State as the full process knitting mill where wool, cotton, and various waste stocks are worked.

Some mills of this class work wool stock only, of different grades.

The majority work mixed stocks. When wool only is worked the hazard is very light. As the proportion of other stocks such as cotton, jute, hair and waste is increased, the hazard becomes proportionately greater.

Waste Stock includes combers, the shorter fibre thrown off in combing long stapled cotton; linters, the waste from a cotton gin; card strippings, waste from the high-grade cotton card; soft and hard yarn and thread waste from spinning and weaving machinery; clippings, from cloth, knit goods and hosiery; rags of all sorts, including old carpet, gunny sacking, etc.; mill waste and sweepings.

Broadly speaking, therefore, the term "waste stock" is applied to the poorer grades of raw material eliminated from manufacturing processes and to any old manufactured stock with fibre long enough to be worked over.

Combers and linters can be distinguished as the fibre of combers averages three-quarters of an inch to one and one-half inches, while the fibre of linters averages one-quarter of an inch to three-quarters of an inch in length. Further, linters in the bale can be distinguished by small particles of the seeds clinging to the fibre.

One of the worst features of waste stock is that it contains a large proportion of foreign material and oil and is therefore more liable to cause fire than the raw material from which it was originally made. It is for this reason, also because this stock being more difficult to work is more liable to cause fires from friction, that it is known as an extra hazardous proposition.

The better grade of waste or clean cotton waste will contain cotton thread and worsted waste ranging in price from eight cents to forty cents per pound. The poorer grades will contain card strippings, card-room fly, oily waste, sweepings, etc., which contain more or less oil and foreign matter and range in price from one-half a cent to eight cents per pound. With the poorer grades will be found jute, which can be classed as extra hazardous.

Shoddy made from wool or cotton rags is the product of the shoddy mill. All shoddy made from cotton or mixed rags or jute when bagged or baled should not be stored or piled away, but should be kept in sight for at least twelve hours after it is manufactured, for any spark that has passed the operator unnoticed packed away in a bale or bag may take from one to twelve hours to eat its way out to the air, possibly causing the destruction of large plants or storehouses and the cause is usually put down to the much overworked theory of spontaneous combustion or rats and matches.

Railroad and Wiping Waste used for cleaning locomotives and other machinery, is also a product made from cotton waste stocks.

There are a number of machines designed to open up these waste stocks and straighten the fibres so that they may be easily worked on the more delicate machinery used later in the process. Practically all these machines are hazardous and some are extra hazardous on account of the class of stock worked.

Packing Waste used for car boxes is principally made from wool carpets and wool threads and the machinery used in its preparation is not considered hazardous, being on a par with a woolen card.

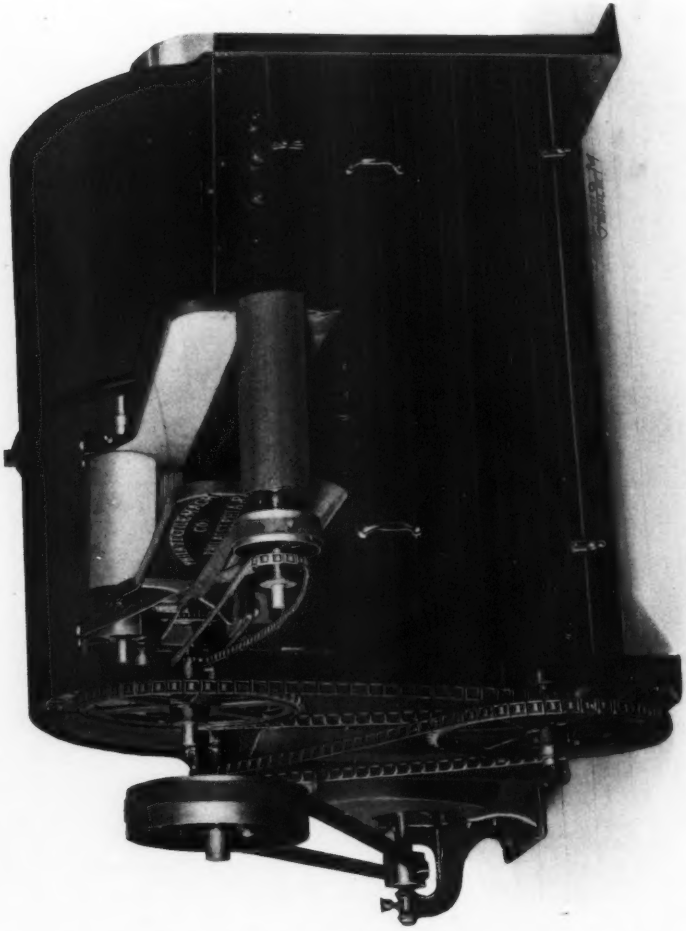
To prepare stock for spinning it must be cleaned, fibreized or reduced to fibre, properly mixed, and straightened. The first machine is usually the duster or willow.

Rear View Box Willow.
By courtesy of Smith & Furbush Machine Co., Philadelphia, Pa.

DUSTERS AND WILLOWS.

These machines are used for cleaning rags, cotton, wool or similar stocks, and for mixing two or more stocks or grades of stocks together preparatory to further work. The machine is in the form of a rec-

tangular box. It is provided with a cylinder or a cylindrical frame in which are set steel teeth or wooden paddles. As the cylinder revolves the steel teeth pass between teeth attached to the inside of the box. A fan is connected which carries off the light dust, while the heavy dust or foreign particles fall through a wire screen or perforated metal sheet



Front View of Cone Willow.
By courtesy of Smith & Furbush Machine Co., Philadelphia, Pa.

set near the bottom. The stock is put in by hand on one side of the machine and there is a hinge drop door on the other side. This drop door is operated by a lever. After the stock is beaten or mixed sufficiently, which fact is determined by the operator, the door on the

discharge side is thrown open and the stock blown out on the floor. The duster can be used for dusting purposes only and is provided with wooden paddles attached to a metal spider. The willow can be used for both dusting and mixing and has a wooden cylinder which contains steel teeth.

This machine is found in most textile mills working mixed stock. Rags are generally worked in a duster and mixed stocks are run through the willow. Some mills use a willow to open cotton, which is then put through the mixing pickers along with other stock, without any further preparing than that obtained in the willow. There is a modification of this machine known as the "cone willow"; it is shaped somewhat after the fashion of a truncated cone laid horizontally. The stock is fed in the small end and comes out of the large end. The amount of mixing or dusting cannot be regulated, as the passage of the stock through the machine and the time it remains in same is entirely automatic from the time it enters until it is discharged at the delivery end.

Hazard.—The hazard is mainly from friction due to the dusty and untidy condition of the heavily oiled bearings. Fires sometimes occur from matches when inflammable stock is being worked. Teeth are set far apart and consequently the probability of striking sparks is considerably less than in some other machines equipped with teeth. This machine is usually to be found in the picker room of a mill, as the stock is put through it immediately before going to the picker. The duster is used in carbonizing plants for separating the carbonized vegetable matter from the wool stock. Sometimes it is connected to a carbonizing dryer by continuous machinery.

PICKERS—(As a Class).

These machines, as the name implies, are designed to open up or fibreize stock. The name covers a variety of machines differing in detail but built on the same general principles. Since pickers were first introduced fifty years ago there has been practically no change in their construction.

There is an enclosure in which is set a cylinder provided with steel teeth which open up the stock as it is fed in between two rolls known as feed rolls. These teeth vary in number from 2,000 to 12,000 according to the stock to be worked, and (with the exception of one machine, the wool or mixing picker) are conical in shape with a gradual taper to the end and extend three-fourths of an inch to one inch in length above the wood lagging. Fine stocks are worked in a machine with the greater number of teeth and the coarser stocks in one with a less number. Some mills carry several extra cylinders with different numbers and diameter of teeth instead of having several pickers.

The stock is fed into the machine from a moving apron through the feed rolls. These are two horizontal, fluted, geared steel rolls about two inches in diameter, the lower one moving on stationary bearings, while the upper has some play up and down and is held down by a weighted arm on each side of the machine. This upper roll is raised or lowered by the amount of stock fed at one time. These feed rolls

revolve in opposite directions at a speed of about twenty revolutions per minute.

As the stock passes through these rolls it is caught and torn apart by the teeth of the cylinder which revolves at much higher speed than the feed rolls, the speed of the cylinder varying from 800 to 850 revolutions per minute.

Pickers usually discharge to an enclosure located in, or adjacent to, the picker room. Sometimes stock is conveyed from pickers by a blower system. This method has been described in previous issues of the Bulletin. A blower system should not be permitted where they are running hazardous stock.

Hazard.—Fires are generally traceable to a few causes: first, the presence of foreign material striking sparks which cause applies to all pickers; second, hot bearings which cause would apply to all; and third, friction caused by the action of the cylinder against the stock on the upper feed roll. This last cause applies more particularly to the rag, shoddy or waste picker and will be described more in detail further on.

It will be seen that the draught created by the machine would give great encouragement to a fire. The picker being a more or less dirty machine to work about, it sometimes happens that the class of help is not of the best, which might be another factor in causing fires. This, however, would not apply generally but would probably be of some moment in mills where a very low grade of waste stock is run through a rag or shoddy picker.

Protection.—Pickers, no matter of what variety, must be treated as hazardous machines. The buildings containing them should be cut off from the balance of the plant. The amount of combustible stock in the picker room should be kept to a minimum. No open lights should be permitted and electric lights should be controlled by switches outside of the rooms on account of the fact that there is frequently a great deal of fly or fine stock present which would lodge on the switch. Parlor matches should not be allowed in any mill. They are the cause of many picker room fires and special pains should be taken to eliminate them.

Chemical extinguishers of approved type and a good supply of fire pails should be ready for quick use. Standpipes and hand hose are also advisable.

Of course the best protection is that afforded by a good system of automatic sprinklers. Care should be taken to equip stock rooms into which the pickers discharge even when these stock rooms are fire-proof. Frequently fires are confined here by sprinklers without any damage to stock in the picker room proper. Dust rooms, if any, should also be sprinkled.

The stock rooms should be of non-combustible construction or at least thoroughly well lined with metal. The same safeguard is desirable in the picker room itself.

A secondary hazard of the picker room is the use of oil on stock. Various heavy oils are used, frequently mixed with water to form an emulsion. Cotton or cotton and wool rags mixed, are not as hazardous with a high fire test oil used on them as they would be without any

oil, for the most hazardous of all rags pickered are those used without oil. The common method of oiling the stock is to spread the batch on the picker room floor and sprinkle the oil from a can. The purpose is to make the stock go through the picker with less breaking of the fibre. The usual safeguards should be followed in the storage and use of the oil.

The degree of hazard in pickers of different type resolves itself largely into the class of stock worked. By good handling of the machine the hazard can be partly eliminated but it frequently happens that low-grade stock and low-grade help go together.

There are three distinct types of picker. The "Rag or Shoddy Picker" is always hazardous; the "Burr Picker" is generally used for wool stock only and when working such a stock has a light hazard; the "Lumper" while somewhat similar in construction to a rag picker is a decided modification of the same and has a comparatively light hazard; the "Wool or Mixing Picker" may have a very heavy or a very light hazard according to the stock worked.

RAG OR SHODDY PICKER.—(*see wood cut*).

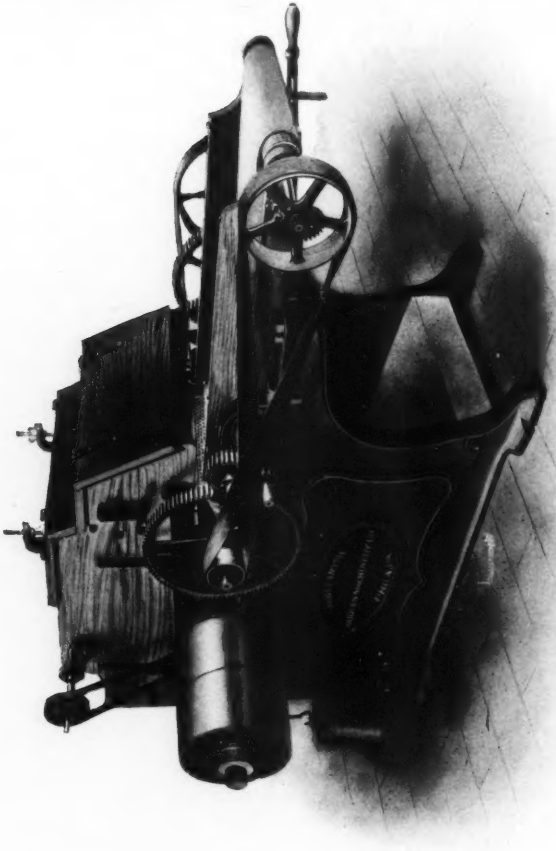
This machine is bound to cause fires because it has an inherent hazard when working cotton rags or jute. There are several different makes, but they are all on the same principle. They are heavily built of iron and steel with wood covers and are used to fibreize all sorts of rags and coarse waste stock. The cylinders are made of steel spiders keyed to a steel shaft and to which are bolted an inside wood lagging. On top of this inside lagging is bolted the outside lagging also of heavy wood and containing the steel teeth.

Hazard.—Before the machine can operate, stock must be wound around either the upper or lower feed roll (depending on the rotation of the cylinder), to a thickness of one-sixteenth of an inch to one-quarter of an inch. This is necessary in order to form a cushion as the action of the wrapped feed roll is to keep the stock against the teeth of the rapidly revolving cylinder, which runs 800 to 850 revolutions per minute as against the twenty revolutions per minute of the feed roll.

There is a common theory that fires in rag or shoddy pickers are caused by the presence of foreign materials striking sparks, or by matches. While no doubt fires do occur from this cause the greater number are due to heating on account of the friction caused by the working of the stock on the cylinder against the stock on the feed roll.

This is the inherent hazard of the machine. While the machine is running the feed rolls gather stock until it is taken away by the teeth of the cylinder. In new machines the sharp teeth prevent excessive accumulation about the feed rolls, but as the teeth wear away and become dulled they allow more stock to gather on the rolls. These dulled teeth present more iron surface against the material and create a greater friction.

The speed roll sometimes becomes covered with such a closely packed excessive mass of stock that it is necessary to use a heavy chisel or hatchet to cut the stock away. The writer has on such an occasion found this stock to be very hot, although extra precaution



Rag or Shoddy Picker.
By courtesy of Smith & Furbush Machine Co., Philadelphia, Pa.

had been taken by the operator to pour water on the roll at intervals of about five minutes during the running of the machine.

As the stocks worked on this machine are low grade and usually very combustible a fire is all the more probable.

The most hazardous stock is probably jute bagging; next in point of hazard are old cotton stockings.

Another point to be noted is that, generally speaking, more friction is caused by the more combustible stocks as they are usually more closely woven, the cylinder must contain a greater number of teeth to open them up, which consequently causes greater friction.

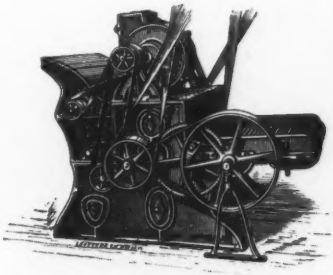
One manufacturer states that rag picker fires can be largely eliminated by pouring a cupful of water over the feed roll every half-hour.

Protection.—The rag or shoddy picker should be in a detached or

cut-off building used for no other purpose, with the safeguards as outlined for picker rooms.

THE BURR PICKER.—(*see wood cut*).

In this machine the feed rolls and cylinder are practically the same as in the rag or shoddy picker, except for an increase in the number of teeth on the cylinder as the stock worked is finer. As its purpose, however, is to remove the vegetable burrs common in wool there is an additional attachment known as the burr roll or extractor which picks up the burrs as the stock passes through.



Burr Picker.

By courtesy of Smith & Furbush Machine Co., Philadelphia, Pa.

A fan is provided to carry off dust and light foreign matter. The burrs fall to the floor of the machine.

As previously stated the hazard of this machine is usually not serious, as it is intended for wool stock only. It is used less than formerly, as cards are now equipped with burring machines which allow the burr picker to be dispensed with in many cases.

However, a burr picker is sometimes used for opening up or mixing combustible stocks, so it would not be correct to state that a burr picker is never hazardous. The hazard must be determined largely by the character of the stock. The friction hazard of the rag picker is not present in this machine to any extent.

THE LUMPER.—(*see wood cut*).

This machine has feed rolls and cylinder similar to the rag or shoddy picker. There is no cover on the machine and no lap is put on the feed roll to hold the stock tightly against the cylinder. The stock passes through easily and the heavy lumps are thrown out over the top of the cylinder while the finer stock is carried off by a blower pipe system or collected in a box at the floor level.

Lumper Picker.

Lumper picker also for mixing before stock is blown to card room. Marks on the wall beyond the machine are from the lumps and hard particles thrown over the guard. The guard is to guide the stock into the funnel of blower system.

The lumper is used for wool or hair or mixed stock. It is the last preparing machine before the cards and as the stock by this time is partially cleaned and the friction developed is very slight the hazard is not serious, compared with that of other pickers.

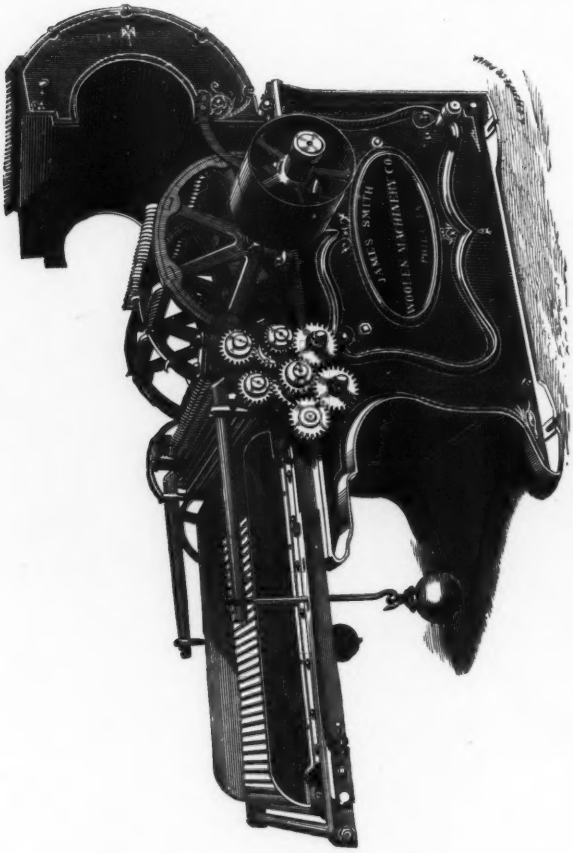
THE WOOL OR MIXING PICKER.—(*see wood cut*).

The wool or mixing picker differs from the rag or shoddy picker in shape and construction. The lower part of the body is similar, but there is a round hinged metal top.

The cylinder is a skeleton frame composed of three metal spiders fastened to a steel shaft. Across the spiders arranged horizontally are steel bars to which are bolted curved pointed steel teeth, similar to claws. These are about two inches long, spaced about two inches apart, and the points face the way the cylinder travels. The speed rolls and apron are arranged in a similar manner to the other pickers. The machine is used in working wool or other stocks that have been previously cleaned, but one of its chief purposes is to mix different stocks or grades of stock together before carding. It will therefore be seen that the degree of hazard lies largely in the character of the stock. The friction hazard as described under rag pickers does not

Lumper.

By courtesy of Smith & Furbush Machine Co., Philadelphia, Pa.



Wool or Mixing Picker With Top Open.
By courtesy of Smith & Furbush Machine Co., Philadelphia, Pa.

apply to this machine to any great degree. There is of course the hazard of hot bearings. Another point to be noted is that frequently larger amounts of raw stock are opened at one time on the picker room floor for this machine than for the others. This arises from the fact that the batch or mix is laid out in layers consisting of the various stocks and it is more convenient to make a rather large batch.

Protection.—All the safeguards as to cut-offs and protection, as previously outlined for pickers in general, should be provided for this machine.

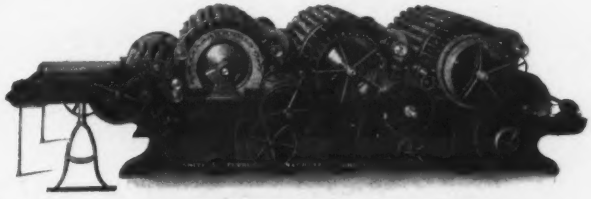
GARNET MACHINES.—(*see wood cut and prints of machines.*)

This machine is seldom, if ever, used for raw cotton or raw wool. It is built entirely of iron and steel and used for heavy work; it is

generally found in shoddy or waste mills, in batt mills, and in any mill where hard waste is worked over for mixing.

It is used for working or reducing as nearly as possible to the original fibre all descriptions of yarn waste from spinning machines, thread and loom waste, clippings, cuttings, etc., and after the stock has been garnetted it has nearly as good a staple as before it was run through the machine.

This machine consists of from one to three main cylinders twenty inches to thirty inches in diameter, above which are arranged small rolls four inches to eleven inches in diameter; all are equipped with steel teeth (similar to a saw edge) on steel wire which is caulked into grooves on the metal cylinders. The main cylinders make about 235 revolutions per minute while the rolls or workers make but six or eight per minute; consequently the more inflammable the stock to be worked the more chance of fire from friction both on the machine and the bearings.



Three-Cylinder Garnet.

By courtesy of Smith & Furbush Machine Co., Philadelphia, Pa.

In mattress and batt factories where a low grade of cotton is used, such as linters, shoddy, etc., the stock is generally fed to the garnet proper by an automatic feeding device which gives an even amount of stock (regulated by weight) usually a Bramwell feed. These machines when working cotton stock create considerable fly (due to the short staple stock) unless they are provided with a metal hood which fits closely over the rolls and main cylinders, keeping down the fly from the shaftings, rafters, etc. These covers are now provided practically on all new machines and have been on those that have been sold for the past five years. The stock while passing through the machine is caught by the steel teeth and straightened and is combed to the floor from the doffer which has removed it from the finishing main cylinder.

Hazard.—In mills in New York State the garnet machine is used for fibreizing cotton hosiery and clippings from knitting mills. Fires can be expected from the machine under these conditions and it should be classed as dangerous as the wool and mixing pickers, and should have the same safeguards.

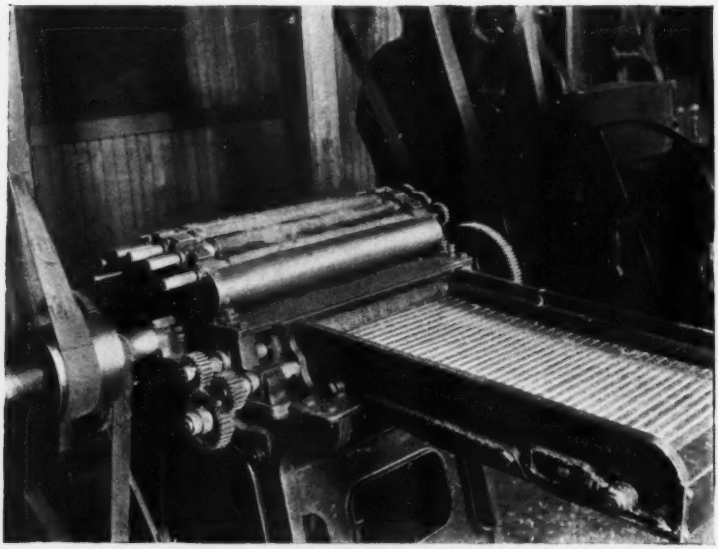
The danger from this machine can be put down primarily as due to foreign substance in stock, such as bits of metal, matches, etc., and from friction due to the character of stock being worked. The machine is all metal and a small fire would simply consume the stock

about same and do no damage to the machine, neither would water hurt same.

Protection.—The machine should be cut off from the main mill and all precautions against spread of fire should be taken the same as for picker rooms.

GARNET PICKER.

This machine is not in general use. It is, as its name implies, a combination of picker and garnet. It can separate almost any fibrous material, such as wool, cotton, hair, jute, etc., and can also be used as a mixing picker. It may be found in first-class shoddy mills. The



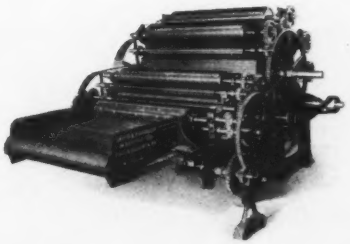
Hard Waste Picker or Type of Garnet Picker for Working Hard Cotton or Wool Ends.

machine contains a thirty-inch diameter cylinder and eight six-inch diameter workers, and is clothed with extra heavy garnet wire toothing similar to a garnet machine and the hazard is about the same. The machine usually works waste stock and it should be located and safeguarded about the same as a garnet machine.

RAG SHREDDER.—(*see wood cut*).

This machine is seldom found except in waste mills which prepare railroad or wiping waste, and is used for shredding rags of various

sorts, such as carpets, sacking, cotton table coverings, towelings, bed spreads, cotton rags and other hazardous stocks. It cleans and opens the stock and in most cases does the work of the duster and rag or shoddy picker. It is also used to prepare certain grades of loose open stock for garnet machines or cards, because longer staple can be obtained than can be procured when an ordinary rag picker or shoddy picker is used. This machine does not so much break the stock as tear it up into shreds, thus preserving the staple. It is built similar to a garnet picker having main cylinder, workers and strippers, these are all provided with steel-toothed wire similar to a garnet or garnet picker.



Rag Shredder.

By courtesy of Smith & Furbush Machine Co., Philadelphia, Pa.

Stock is usually fed by hand on an open apron. Hazard can be classed as heavy, due to the low grade of waste stock which usually contains a large amount of foreign matter, and as this stock receives no preliminary cleaning other than mixing or batching by spreading out over the floor, fires are numerous both from friction and by foreign matter. The machine should receive the same safeguards as pickers. Approved chemical extinguishers are very essential about these machines, and hand hose is also very useful.

The shredder that is used for making packing waste for car boxes is not considered hazardous as the material used is either wool or nearly all wool (such as wool ingrain carpets, etc.). The machine can be distinguished from the cotton rag shredder, as it contains but about one-half the number of teeth in it.

THE CARD.

The card is the last preparing machine for the yarn before it is spun.

It straightens out the fibre and delivers it in small strands or rovings twisted just enough to hold together while being wound on spools for further spinning.

The hazard and protection of the card room will be discussed in a subsequent paper.

GENERAL REMARKS.

Inspectors have experienced considerable difficulty in comparing mills of the same class, for it appears that with mills working similar stocks on practically the same machinery, some will have frequent fires while others will be largely free from same. This leads to the conclusion that the fire hazard depends on the handling of the machine as well as on the quality of stock.

In others words even with so-called hazardous machines, such as the general class of pickers and garnets, the frequency of fires can be materially reduced through proper care and management.

The following is a brief list of the raw stocks, the machinery and the principal hazards to be found in certain textile mills:

WORSTED YARN MILL—FULL PROCESS.

Raw Stock.—Raw wool of good grade, lard and olive oil, soap and soda ash.

Machinery.—Burr and mixing pickers, duster, wool scouring machines and dryers, two-cylinder wool cards with doffer between, combers, gill boxes, drawing frames, roving, spinning and twisting frames, winders and spoolers.

Hazards in this class of mill are light. The stock does not support combustion. There is the slight ordinary hazard from the drying processes.

HOSIERY YARNS—COTTON.

Raw Stock.—Raw cotton of good grade.

Machinery.—Bale opener, cotton pickers, spreaders or lappers, flat cotton cards, drawing frames, slubbers, speeders, spinning mule, spinning frames, cone and skein winders.

Hazards are heavy in the picker room of these mills, but after the stock has passed through the lapper it has been well cleaned, and the danger of fires in the carding and spinning rooms is greatly lessened.

CARPET YARNS—COTTON.

Raw Stock.—Cotton linters, cotton combers, wool oil.

Machinery.—Mixing or wool picker and a lumper picker. Wool cards usually two to a set. Mule frames for spinning and reels for winding.

Hazard is heavy both in the picker room and card room, due to the inflammability of the stock and the excessive flyings from the short staple stock. Wool oil is used to prevent breaking of the staple and to help hold the stock together.

CARPET YARN MILLS—INGRAIN—A MIXED WOOL YARN.

Raw stock.—Old woolen carpets, cattle and goat hair, pickered jute, wool and lard oil.

Machinery.—Duster and willow, rag and mixed pickers. Wool cards usually two to a set, or at times, where double reeling or a better working is desired, there are three to a set. Mules for spinning. Reels for winding.

Hazard is somewhat heavy, due to the working of jute and carpet rags. There is also a slight chance of a fire in the card room, but as a whole is not as hazardous as a mill working a mixed cotton stock.

WOOL SHODDY MILL—FULL PROCESS.

Raw Stock.—Woolen rags. Sulphuric acid and common salt or muriatic acid and dye stuffs.

Machinery.—Carbonizer, duster, screen or cyclone dryers, rag or shoddy pickers, double-cylinder wool or shoddy cards, baling press.

Hazard is somewhat heavy in the picker house, but comparatively light in other parts of the mill, mainly from the coke fires of the carbonizers and the usual drying hazard. The dust from the carbonized stock after passing through the dusting machine is subject to spontaneous combustion and should be stored away from the main mill. The carbonizing fumes are very corrosive and if there are any sprinklers located near same they should be examined frequently and replaced if corroded by a corroproofed or coated type of sprinkler.

It is to be noted that, while this stock does not support combustion, it produces a pungent, overpowering smoke, which makes it impossible for any one to fight a fire at close range.

WASTE—RAILROAD AND WIPING.

Raw Stock.—Woolen and cotton carpets, old rags, lace curtains, etc., wool oil.

Machinery.—Rag and carpet shredders, willow and a baling press, while some mills will have a rag picker and rag or carpet shredder.

Hazard is very heavy as they use a low grade of waste stock. The oiled cotton rags are subject to spontaneous combustion if a low fire-test oil is used and they are put in a hot place and allowed to stand over night. The dust from the machines should be well cleaned up and removed from the mill. Hand hose near the shredders has proven of valuable service in this class of mill.

WOOLEN AND WORSTED SUITINGS FROM YARNS.

Raw Stock.—Wool yarns, also small amount of cotton warp yarns.

Machinery.—Winders, warp frames, spoolers and weaving looms.

Only hazard is in the bearings of the looms and the lighting hazard particularly about the looms.

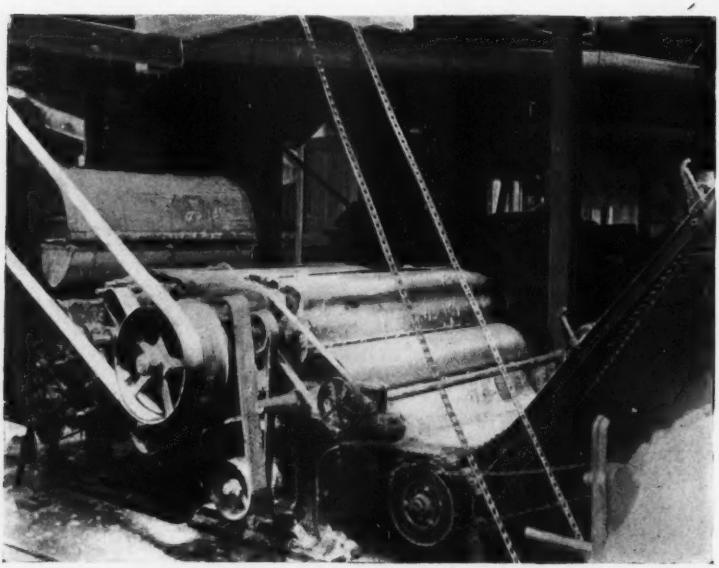
COTTON SUITING WEAVE MILL—FULL PROCESS.

Raw Stock.—Cotton rags, cotton linters. Hard and soft cotton waste from the spools, looms, etc., and card room sweepings, strippings, etc. Dye stuffs.

Machinery.—Duster, mixing picker, rag or shoddy picker, garnet, washing and dyeing tubs, can or screen dryers. Wool cards "three to a set." Mule spinning frames, winding, warping and beaming frames. Weaving looms. Nappers, shearing machines, calendering and folding machines.

Hazards are heavy in the picker and card rooms, due to the low grade of stock. There is also a hazard from the dust of napping and shearing machines which should not be allowed to accumulate. There is a slight hazard from the steam-heated calenders, also the ordinary drying hazards.

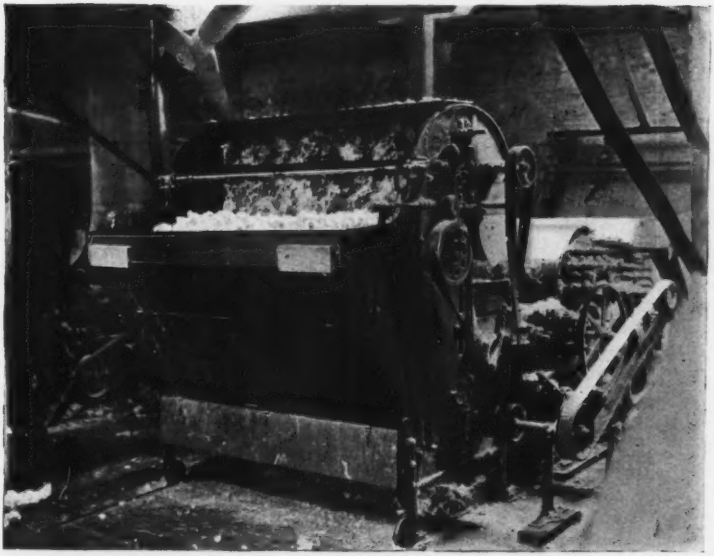
The above class of mills makes goods for ten to twenty-five cents per yard and they have had numerous fires. The mill making a better grade of goods to sell for eighteen to thirty-five cents per yard will work wool shoddy and silk noils in addition to the above low-grade cotton and will work up more rags instead of cotton linters. The hazard is practically the same.



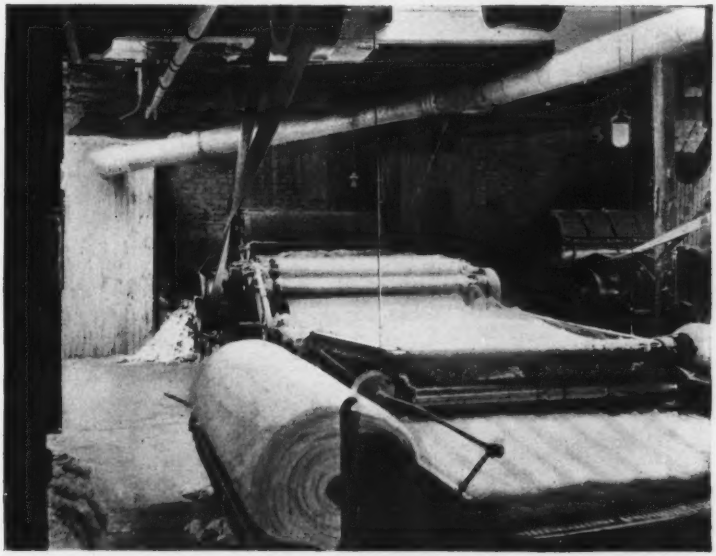
Two-Cylinder Garnet Machine With Cover Over the Cylinder and Workers. Camel Back Apron Feed.

COTTON MATTRESS AND BATT FACTORIES.

Raw Stock.—Raw cotton, cotton picker waste, cotton linters, excelsior, sea moss, corn husks, African fibre, jute, hair, silk, floss, feathers, ticking, and some factories use a stock of old cotton comfortables.



Bramwell Feed for a Garnet Machine in a Batt or Mattress Factory.



View of Garnet Machine With a Blamire Apron Feed in a Mattress and Batt Mill.

Machinery.—Willow, mixing pickers, lumper picker, two-cylinder garnet machines, wool cards, mattress stuffing machine. Feather steaming machine, crusher, cutter and rag pickers.

Hazards are very heavy in the picker house and throughout the factory both from the working and storage of the highly inflammable low-grade stock, also from hot bearings of the machines and the lighting and heating hazard.

HOSIERY MILL—COTTON AND LISLE COP YARNS.

Raw Stock.—Egyptian spun cotton or lisle yarns, also the heavier American cotton yarns all on cops. Dye stuffs as aniline colors, bleach or chloride of sodium, oxidizing agents as sulphide of sodium, bichromate of potash, chloride of potash, sulphuric and muriatic acids.

Machinery.—Knitting and looping machines, napping machines, wash and dye tubs, whizzers or extractors, oxidizing wheels or tumblers, dry rooms, singeing machines. Cyclone hosiery or ordinary dry rooms, steam-heated presses.

Hazards are fairly light, singeing and drying; at times gas fired for leading needles.

WM. H. FISHER, *Inspector,*

The Underwriters' Bureau of the Middle and Southern States.

Modern Fire-Proof Power Houses.

Electric power stations are increasing in number very rapidly in this country and can be most desirable or most undesirable fire risks, and, as a class, vary between wider extremes than the risks in most classifications. Power stations built in the last few years are, with some exceptions, good fire risks, for the reason that fire protective features lend themselves very readily to the design, without in any way interfering with the use to which the plant is to be put. Also, because the great horror to the operating department of a traction or lighting system is a "shut down," the engineers are more apt to follow the advice of fire insurance experts than is the case in some other lines of business.

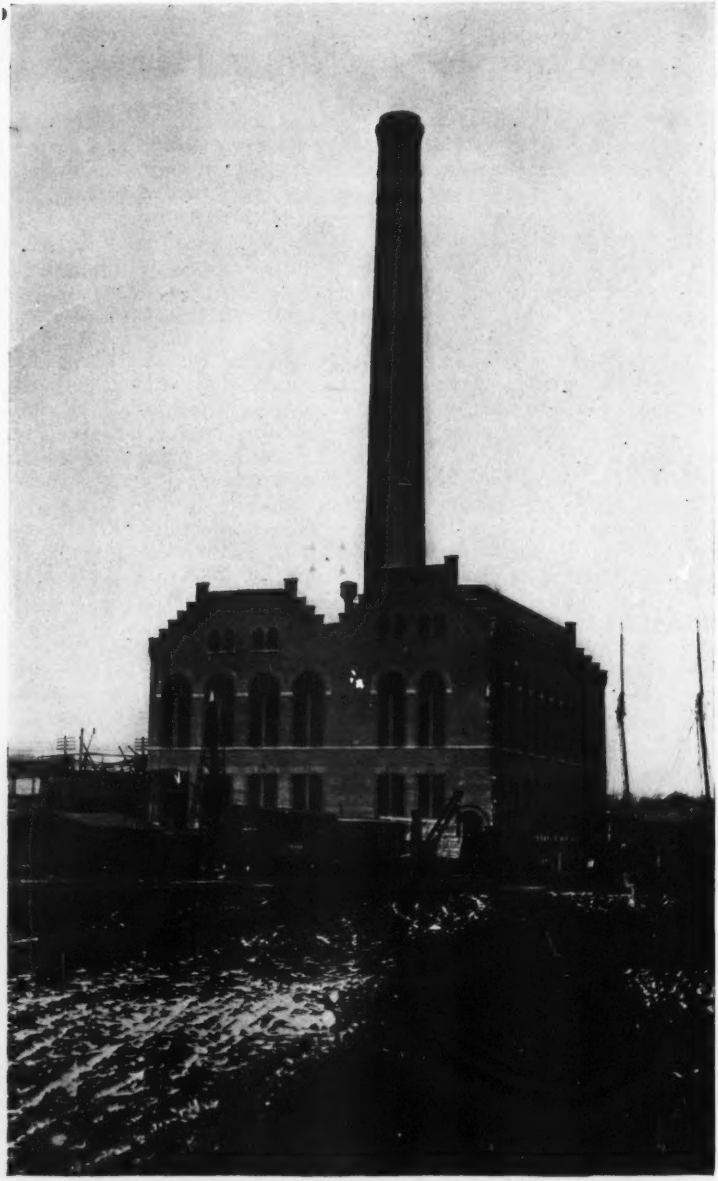
Disregarding exposure, a power station can be built that will be perfectly practical from an operating and financial standpoint, and at the same time as safe as the average fire-proof office building, and should be subject to no greater or more frequent losses. To do this, however, every item of arrangement, construction, and the handling of the electrical features should be given the most careful consideration. If proper talent is employed on this, the corporation owning the plant will have a risk which should be practically free from interruptions to service or shut downs from fire, and it should be a very durable, sightly, and an altogether satisfactory station.

To begin with, the structure should be entirely of fire-proof construction, and this should be rigidly adhered to in every portion of the plant and premises. Any of the several satisfactory systems of fireproofing can be employed, and it will be found unnecessary to depart in any marked degree from what is considered the best practice in fire-proof construction.

Location, size, and the particular service to which a station is to be put, will vary the details somewhat, but the following is a composite word picture of several very excellent stations, with some comments and explanations.

All outside walls and any division walls and partitions will be of brick, concrete or other appropriate materials, the use of stone or ornamental outside finish, particularly in exposed locations, not being recommended. All roofs should be of fire-proof construction, except that in generator rooms of large span it is not considered a defect if they are supported by unprotected steel work. All windows should be of wire glass in standard metal frames, and all doors to be metal, or wood metal-clad. It is a good practice to equip all doorways, whether in partitions, division walls, or outside walls with standard fire doors. The finish of the whole inside of the station should be perfectly plain, no plastering, sheathing, or woodwork being allowed. Small enclosures, closets and concealed spaces should be dispensed with, so that there can be no accumulations of rubbish, or unnecessary articles in any part of the plant. Coat closets should be of metal with mesh doors and be grouped in a room by themselves, and under proper supervision.

The generator room is usually one high story in height, with sufficient head room to accommodate travelling cranes. The floor of the room is of



Typical Fire-Proof Station.

some type of fire-proof construction, with a granolithic surface, which is pierced by numerous holes to accommodate the machinery, stairways and piping connections. To facilitate the erection of the switchboards and their connections, the portion of the floor under them is sometimes made of wood, which is a defect and is not necessary. If the switching apparatus is on a gallery, this whole structure should be of fire-proof construction, all wood trim and railing being left off. It has been proposed in some cases to divide the generator room into two or more fire sections, but, except in very large stations, this is not necessary and is not favored from an operating standpoint. The under floor space in this room contains all auxiliary machinery connected with the engines and dynamos, as well as the foundations of these machines. Great care should be exercised that no woodwork or combustible materials are used in this room, and it is advisable to so design the station that this room will be lighted and ventilated by outside windows. Where this is impossible, it is wise to keep all portions of this space brightly lighted at all times, as it promotes cleanliness and also in case of trouble men can find their way around in it without difficulty. The material which enters into the covering of the cables and piping in this space should be carefully investigated and incombustible material used as far as possible. The pockets for the bolt heads in the machinery foundations should be bricked up, and, where possible, the pits in which the generators revolve should be built large enough to admit of easy inspection and cleaning.

This basement space in stations which deliver underground, sometimes have motor switches, lightning arresters, complicated masses of cables and even transformers. In designing a station, this use of the room should be avoided if possible, but if it is found necessary to install any of this apparatus in this space it should be cut off, by fire-proof partitions or walls both vertically and horizontally.

The boiler room is ordinarily cut off from the generator room by a heavy brick wall. This wall of course is pierced by many openings for piping as well as doorways. It is difficult to protect these openings so as to make this wall a standard cut-off, but in a station like the one now under discussion this is not considered necessary. The boiler rooms differ in the different stations more than do the generator rooms. There is generally a basement which contains the ash transfer system and some minor machinery. There is then one, two, and sometimes three, tiers of boilers, each of which is surrounded by a fire-proof floor. Above this there is either a room which contains the coal distributing machinery used in connection with the mechanical stoker equipment, or, in some cases, a superimposed coal-pocket, over which comes a roof similar to that over the generator room. From an insurance standpoint, this coal-pocket is a hazard, and by many station engineers is not considered desirable from an operating standpoint. However, due to land values or other considerations, this arrangement is sometimes deemed advisable. All of the metal members of the portions of the building used for coal storage should be carefully protected and where soft coal is used the pocket should be divided into sections holding not more than 500 tons each. Some system of keeping a check on any marked rise in temperature in the coal should be installed, and the chutes so arranged that any one section can be emptied

Generator Room Showing Switching Gallery.

promptly should it show signs of heating. Outside coal storage is generally provided. In this case some form of conveying machinery is installed and the coal taken into the station over the boilers and discharged into the hoppers of the mechanical stokers. With this arrangement, there is a comparatively small amount of coal in the boiler room at one time. The boiler room section is with difficulty kept up to the proper standard of cleanliness, but if it is designed and maintained without minor partitions, closets and nooks to become catch-alls, and then well lighted either naturally or artificially, this trouble is largely overcome.

Ashes are usually handled by machinery, and the ash bin is, where possible, a separate structure. Ashes are dumped into it from above, and delivered into scows or cars through a hopper at the bottom. As the ashes contain enough coal to burn after being dumped into this bin, it is necessary that it be designed so these fires will not damage the structure. This requires an extra thickness of protecting material for the metal parts.

Probably the worst hazard about a power station, is the oil-cooled transformers. Where these occur, they should be put in a detached building if possible. If in the station building proper, they should be in a room cut off with access only from outside. This room should be used for no other purpose, and the wiring and electrical fittings in the room should be reduced to a minimum. The room should be arranged to drain into a blind pit. Piping off the cases of the transformers is not necessary. A transformer without oil in it takes damage from fire much more readily than when filled. The transformers should be set on non-combustible bases, and the wooden parts sometimes furnished with them should be removed. Sometimes each transformer is put into a separate cell. This arrangement has its advantages, but it also has its disadvantages from an operating standpoint.

The oiling system in this class of stations generally consists of a gravity feed from a tank holding about 50 gallons or less, which is in some elevated position in the generator or boiler room. This tank is connected by a system of piping to all the principal bearings about the station, and to several stands where the hand oil-cans are filled. The oil-tank is filled by pump from the oil room. If detached, this room should be fireproof well lighted both naturally and artificially, and heated by steam. If incorporated in the main building, it should have access only from out of doors. If this arrangement is found impracticable and it is made to communicate, the doorway should have a threshold 12 inches high, and should be protected by a standard swinging fire door, fitting very tightly, and an automatic sliding door. This room should be drained to a blind pit. It is well to have this room only large enough to hold a reasonable supply of oil.

Storage batteries, where they occur, are in a room by themselves, tightly shut off from the rest of the plant on account of the corrosive gases arising from them. The cells are generally on concrete or metal supports, and the granolithic floor is arranged to drain. The room should be well ventilated, as under certain conditions the gases are inflammable. It should be used for no other purpose, the storage of acid being prohibited.

Boiler Room in Full Operation, Showing Details of Construction, Arrangement of Apparatus for Handling Coal and Ashes.

Notice cleanliness of room.

The electrical hazards are generally very well safeguarded in a station of this sort. All wire, fittings, and apparatus should be of approved types, and the "National Code" should be strictly adhered to in this installation. Cables should be installed on non-combustible supports, and grouping of cables should be avoided as much as possible. It is important that all wiring with the exception of the heavy cables should be installed in conduits. It is advisable also to have the cables either in conduits or in ducts built into the walls and floors of the station. This latter arrangement sometimes meets with objections from station engineers, but there is no record of trouble having occurred where this plan has been carried out.

The wire tower of the old-time station seldom, if ever, occurs in the modern plant, the main cables being led directly from the basement into underground conduits. It is often found necessary to partition off the portion of the basement where the cables leave the plant, on account of the illuminating gas that finds its way into the building through the open ends of the conduits. This room or space should be well ventilated and lighted by lamps in keyless sockets with controlling switches outside.

High tension circuit breakers and large oil switches should be installed in compartments by themselves.

The station is of course lighted by electricity, sometimes the current being taken from some other source, so that in case of trouble to its own apparatus its lighting will not be interfered with.

The modern machinery in the generator room is not as susceptible to damage by fire and water as was the machinery of a few years ago. There is almost no belting in the plant, all dynamos being direct connected. Some of the turbine sets are in a protecting housing, and much of the wiring about the machines is made with non-combustible and water-proof covering.

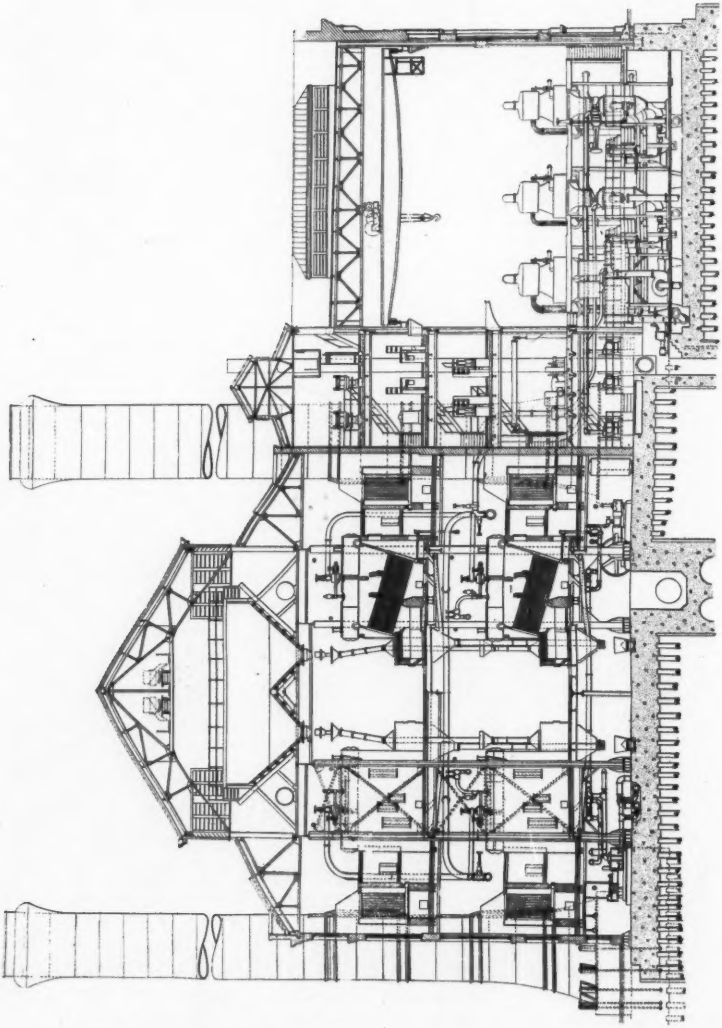
The engines are equipped with automatic engine stops so that each unit can be stopped promptly in case of trouble. These, with the proper protective devices in the circuits and the modern switchboard apparatus and control, make a fire among the machinery a rather remote possibility.

A station thus built and equipped is easily kept in satisfactory condition from a fire standpoint. Ordinarily it will be in constant operation, with men on duty at all times, but a good watchman service covering all unfrequented portions should be required. A supply of standard waste cans and chemical extinguishers should be provided, and the necessity of order and cleanliness impressed on the personnel.

With the construction, equipment and care here outlined, the modern power station can be looked upon as a good fire risk.

The following are extracts of reports of several fires that have occurred in stations of this character. There have been several losses resulting from fires originating in exposures, but they will not be mentioned, as they in no way involve the hazard under discussion.

No. 1. "The immediate cause of the fire was not definitely known, but it is supposed to have been caused by transformer burning out and setting the oil on fire. The tanks which contained the transformers were made of about No. 16 iron, which is riveted and soldered together at the joints. When the oil caught fire, of course the solder melted and



Cross Section of Modern Station Showing Two Tiers of Boilers, Superimposed Coal Pockets and Other Details of Construction and Design.

By courtesy of McGraw Publishing Co.

allowed the oil to run all over the floor and down the shaft, setting fire to the insulated wire and the wooden supports to which the wires were fastened. All the wiring in the shaft was rubber covered, and when it caught fire it burned rapidly. Only three of the transformers were fit to be used at all, and they burned out in about four days after being put in service."

No. 2. "The building was entirely of brick, cement and iron.* * * * There was a loss of about $4,500.* * * * The fire is attributed to the overloading of the transformers and the firing of the oil."

No. 3. "The electricity jumped the lightning arresters and set fire to a 10,000 volt oil switch in No. 1 Power House."

No. 4. "Coal was dumped by mistake into ash bin partly filled with hot ashes. The ash bin structure and conveying machinery therein was seriously damaged. The fire communicated with the main station through the conveyor bridge and warped some of the roof members."

No. 5. "Fire was discovered in the coal-pocket over second tier of boilers.* * * * After several hundred tons of coal were run out of the pocket and as much more shovelled over, the fire was brought under control."

C. B. MACKINNEY,
Starkweather & Shepley, Providence, R. I.

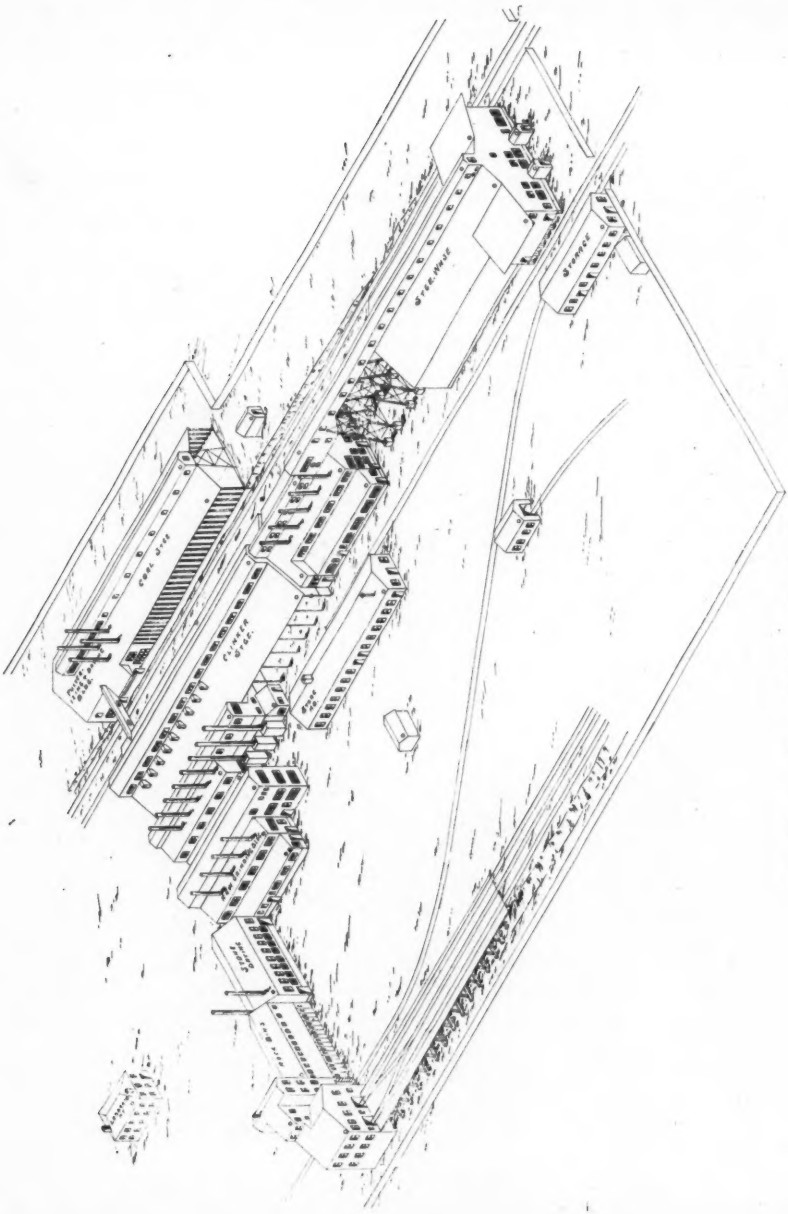


Fig. No. 1. General View of a Modern Cement Plant.

The Cement Industry of the United States.

PART II.

PROCESSES AND HAZARDS.

In a preceding article which appeared in the July, 1907, number, the historical and statistical side of this subject was briefly discussed by the writer. For the latest statistics the reader is referred to "The Cement Industry of the United States in 1906," prepared under direction of Edwin C. Eckel and published by the United States Geological Survey. This report contains information of a most interesting as well as valuable nature. Under the caption of "Advances in Cement Technology," by Edwin C. Eckel, will be found information on the following features: Growth of the Portland cement industry, raw materials in use, kilns and kiln practice, localization of the industry, the difficulty of monopoly, normal growth and concentration, capitalization and promotion; while under caption of "Statistics of Cement Industry in 1906," by L. L. Kimball will be found information on production by states, of Portland, natural and puzzolan cements, imports and exports and notes on cement production in Canada and other foreign countries.

In this paper it is not the purpose of the writer to dwell on the subject strictly from an underwriting standpoint as this has already been thoroughly covered in Mr. F. M. Griswold's article on "Cement Plants and Plaster Mills," published by The Home Fire Insurance Company of New York City, and to which the reader is referred.

A description of processes and hazards as they pertain to Portland Cement Plants (Dry Process) will only be attempted at this time.

In General.—Up to within the last few years (three or four) not much thought has been given to designing cement plants except from the manufacturers' viewpoint, with the result that compactness of the various mechanical processes and resultant congestion of the various buildings composing the plant was secured at a sacrifice to good fire underwriting principles.

The usual processes of a typical Portland cement plant, exclusive of the mining and quarrying operations, are as follows: (1) The Power Generating Plant, (2) Rock Crushing, (3) Rock Drying, (4) Raw Grinding, Weighing and Mixing, (5) Kiln Burning and Clinker Storage, (6) Coal Storage, Drying and Pulverizing, (7) Finished Grinding, (8) Storage and Shipping. Not infrequently are all these processes found practically under one roof and even then in buildings of inferior construction.

Figure No. 1 serves to give a general view of a well-known Portland cement plant situated in the South. It will be noted that outside of the coal pulverizing mill and storage warehouse the rest of the plant is under one roof. The buildings, however, are of superior construction, being principally of steel skeleton frame, covered with corrugated iron and cement on expanded metal and resting on concrete

foundations. The clinker storage pit is cut off by blank concrete walls on two sides and building is open on other two sides.

The electric power house is detached about 800 feet south and furnishes all of the power for the plant as well as steam, compressed air and water for the quarry located about 500 feet east of both plant and power house. The power plant is complete in every detail including improved methods of handling coal and ashes.

North of the plant is located the Company's hotel, also store and operatives' dwellings, so that the plant with all of its environments forms a community by itself.

The following description of processes and hazards will apply to most of the Portland cement plants using the dry process, but particularly to those situated in the southeastern territory.

QUARRYING.

Various methods for breaking down the rock are in use; those most suitable to meet local conditions are of course employed. Pneumatic drills and dynamite are used for disrupting the rock while steam shovels for loading the small tram-cars or skips are often used. These are of several tons capacity and are mounted on small flat cars, and convey the rock from the quarry to the crushing plant. Frequently water-mains are extended to the quarry and used for washing free dirt from the rock. About the only hazard in connection with this work is the use of dynamite and the caps for exploding same. These should be stored in separate well-detached (from buildings of plants and each other) solid brick or stone magazines.

CRUSHING.

The raw material (limestone rock and shale) received from the quarry, is first passed through ore breakers, often termed jaw breakers or crushers, where it is broken up into small roughly shaped pieces.

Crushers are usually of the gyratory or the jaw crusher type. After crushing the rock is sometimes passed through crushing rolls where it is further reduced to three-quarters of an inch and smaller.

The crushed rock as it is discharged from the crushers or rolls is then delivered into bins or other storage deposits by means of an elevator, (see Figure No. 2), first passing through revolving screen and separator or direct to stone dryers. Figure No. 3 shows a sectional elevation of rock crushing plant in which will be noted a crusher, elevator, revolving screen and separator and storage bins under. The screenings and fine stone produced will supply material for cement making while the larger sizes can, if desired, be marketed for ballast or aggregate used in concrete making.

Usually a sample of rock or shale is taken from each tram-car load and an analysis made so that the average content of each storage bin of crushed rock is known.

The hazard presented is mild, if any.

From the storage bins the crushed rock is conveyed to the Rock Dryers.

Fig. No. 2. Crushed Rock Elevator.

By courtesy of the Allis-Chalmers Co., Milwaukee, Wis.

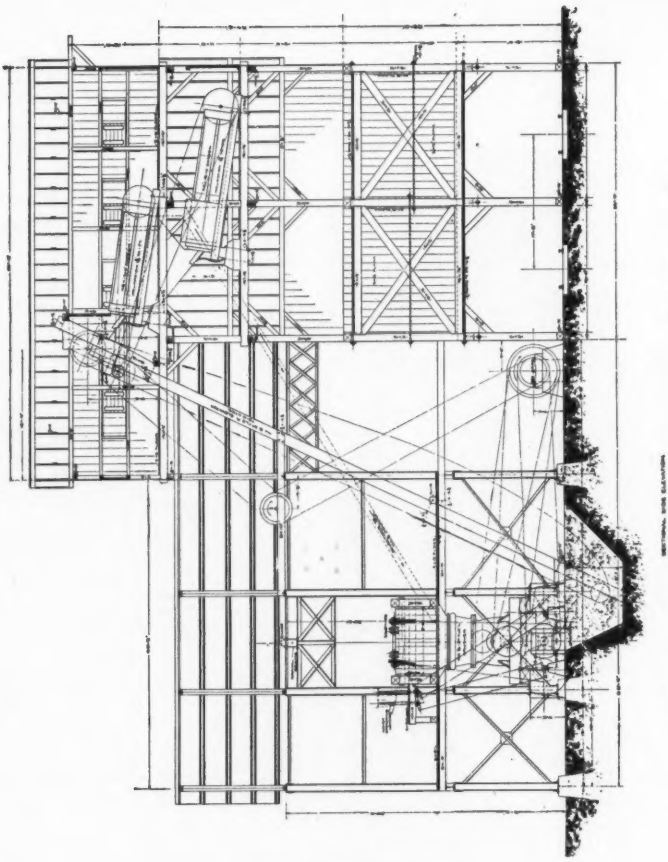


Fig. No. 3. Showing Arrangement of Crushing Plant.
By courtesy of Allis-Chalmers Co., Milwaukee, Wis.

ROCK DRYING.

It might be well to call attention at this point to the fact that raw materials, as they are received from the quarry or mine, almost invariably carry an appreciable though often very small percentage of water. Hard limestones will carry water to the extent of ½% to 3%, though rarely reaching or exceeding the latter figure. Chalky limestones absorb water very rapidly, but the quantity can be kept down to 5% or less usually except in prolonged wet weather when it may be necessary to handle material containing water as high as 20%.

In dealing with the clays and shales a much more complicated case is presented.

In shales the mechanically retained water will rarely exceed 10% and is usually below that point, although an additional 2 to 7% of

water will be carried in a state of chemical combination. In the clays the moisture may vary from 1% in air-dried clays to 30% in fresh clays. The chemically combined water varies from 3 to 10%. The hydroscopic or mechanically held water can be driven off at a temperature of 212° F., while the chemically combined water is eliminated only at a low red heat. The total water, therefore, in clays may vary from 4 to 40% according to conditions of weather, drainage of the pit and subsequent care taken in protecting the materials from further exposure. In some plants marl is used with clay in a dry process. Marl usually carries about 50% of water.

It will be observed, therefore, that cement raw materials may carry from 1 to 50% of water when they reach the mill. In the dry process of making cement it is necessary to remove practically all of this moisture for the following reasons: First, fine pulverizing and reducing cannot be satisfactorily accomplished unless absolutely dry materials are fed to the grinding machinery; second, the presence of moisture in raw materials complicates the calculations of the mixtures.

The simplest type of dryer and that most commonly in use consists of a long metal cylinder, approximately from 40 to 50 feet in length and five feet in diameter and set at a slight inclination to the horizontal and rotating on roller bearings. (See Figure No. 4.) The raw material is fed in at the upper end of the cylinder, moving gradually downward under the influence of gravity as the cylinder is revolved. Frequently angle irons are bolted to the interior in such a fashion as to assist in the drying of the material. The cylinder is heated by either waste gases from the rotary kilns or by a separate furnace, the products of combustion in either case being introduced at the lower end of the cylinder, and induced by draft through same, escaping by metal stack connected to upper end.

In drying raw material containing high percentages of water, a double cylinder is employed. The material to be dried is introduced into the space between the inner and outer cylinders, while the hot gases first pass through the inner cylinder and then in the reverse direction between the inner and outer cylinders. This type of dryer is largely employed in slag cement plants and to some extent in Portland plants.

The cost of drying will, of course, depend upon the cost of fuel, the amount of water in the raw material and the type of dryer. From five to eight pounds of water per pound of coal can be usually evaporated in the various types of dryers commonly in use.

From the dryers the rock goes to the raw grinding machinery and in some plants is passed through another set of rolls before entering the raw stock storage bins if not sufficiently reduced.

Clay or shale from the crushers is dried in about the same manner as noted for rock and after a preliminary grinding is conveyed to the raw stock storage bins to be mixed with the crushed rock.

Hazards.—The hazards of rock drying are as follows: Nature of the fuel used and manner in which it is stored, and care of ashes from the furnaces; stacks for carrying off the hot gases should be safely arranged and of sufficient height to induce good draft and at the same time reduce the spark hazard to the minimum. There is to some ex-

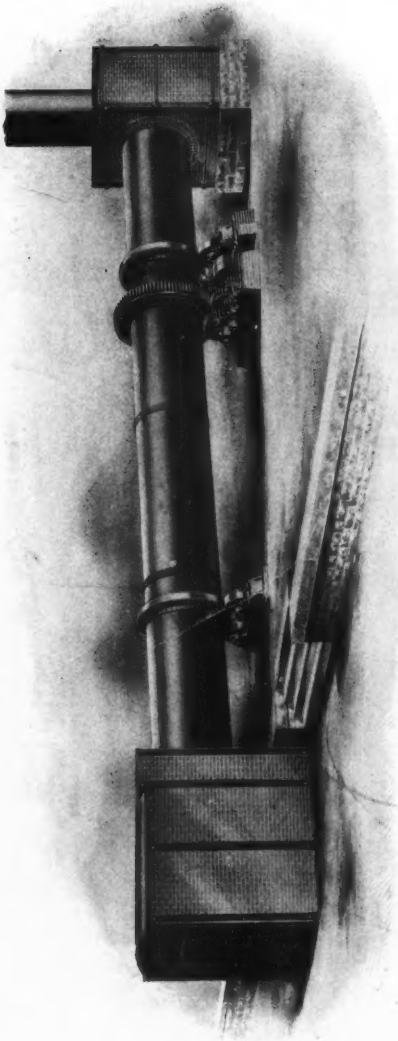


Fig. No. 4. Rotary Dryer.

By courtesy of Allis-Chalmers Co., Milwaukee, Wis.

tent a hazard presented in the raw stock at this stage; the hazard is not very pronounced, as it is only intended that the rock shall be sufficiently heated to drive off the natural moisture. However, only conveyors of all metal should be used in transmitting same to the raw stock storage bins, which should also be of metal. Dryer and furnace should be kept well away from all woodwork, as flame and sparks are allowed sometimes to escape at the junction of the dryer and the furnace.

RAW GRINDING AND MIXING.

A portion of the grinding is usually accomplished before the drying process, but the principal part of the reduction takes place after the two necessary raw materials have been separately dried when they may be mixed immediately, or each may be further reduced separately before mixing.

The mixing may be accomplished by means of automatic mixers, of which there are many types on the market. These will produce mixtures in proportions pre-determined from analysis of the materials.

The further reduction of the mixture is usually carried on in two stages, the mixture being ground to about 20-30 mesh in ball mills, Kominuters, Griffin mills, etc., and finally reduced in a tube mill. At a few plants single stage reduction is practiced in Griffin or Huntington mills. At one of the Edison plants in New Jersey the reduction is accomplished through a series of rollers.

The majority of the plants, however, use either a combination of the Griffin and tube mills or the ball and tube mills and there is probably little difference in cost in operating these two combinations. It is considered by some authorities that the ball mill has not been quite as much of a success as the tube mill and has been replaced at several plants by the Kominuter.

Ball Mills were originally designed to produce from very coarse material a finely finished product in a single operation. To accomplish this the outside or finishing screens were required to be of the necessary fineness. As modern practice in Portland cement making demands a product of which at least 92% shall pass a 100-mesh screen, a marked reduction in capacity resulted caused by difficulty in keeping the screens open.

The introduction of the tube or pebble mill removed this objection, as it left for the ball mill only the work of preliminary reduction, say to 20-30 mesh.

The ball mill consists of two circular side plates each provided with shelves projecting inwardly and eccentrically placed. (See Figures 5 and 6.)

The side plates, or heads, have rigidly attached at their centers hubs which are mounted on a heavy shaft revolving in dust-proof bearings. One of the hubs has a suitable opening through which the material is automatically fed. Forged steel balls of extra hardness from two to five inches in diameter are introduced and occupy a small proportion of the space inside. The combined weight of the balls varies from 3,000 to 4,500 pounds according to size of machine. The tumbling of the balls and material due to the revolving action of the

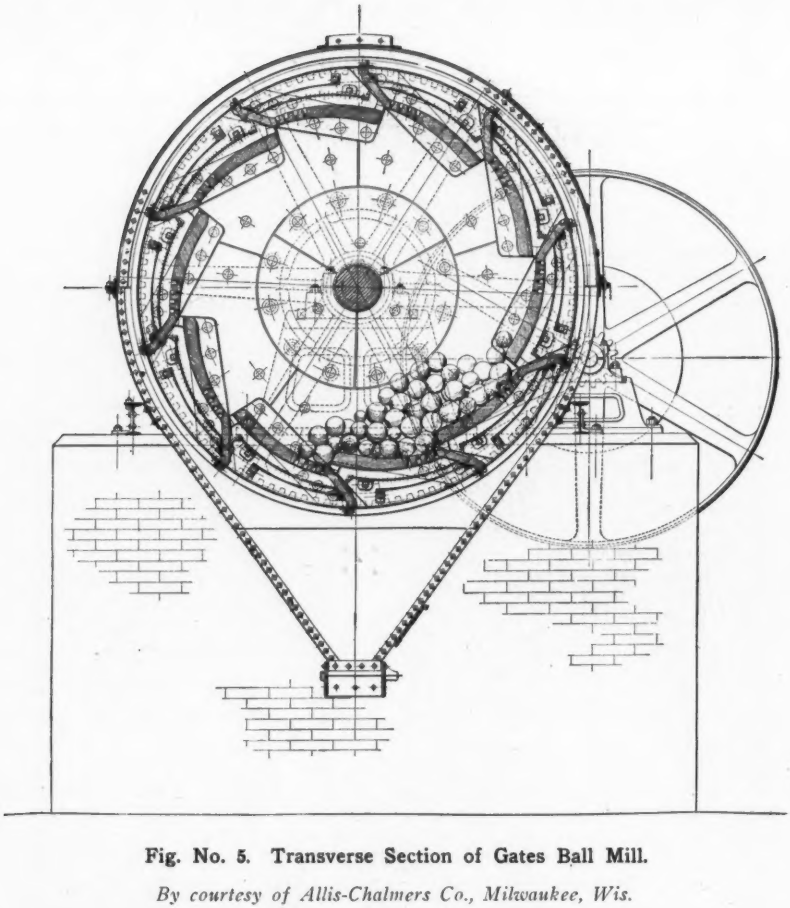


Fig. No. 5. Transverse Section of Gates Ball Mill.

By courtesy of Allis-Chalmers Co., Milwaukee, Wis.

drum rapidly reduces the material to fine grit and powder, the steps serving to greatly increase the beating action of the balls.

When partially reduced the ground product falls through apertures in the wearing plates to the first screen. The reductions from this screen are promptly returned to the mill through to openings in the overlapping plates while the "fines" go to the outside finishing screen and the material passes through falls into the dust-proof enclosure to be removed by conveyor for final pulverization The residues join those of the other screen and together they are returned to the mill to be subjected to a further grinding action of the balls until they are fine enough to pass the finishing screen.

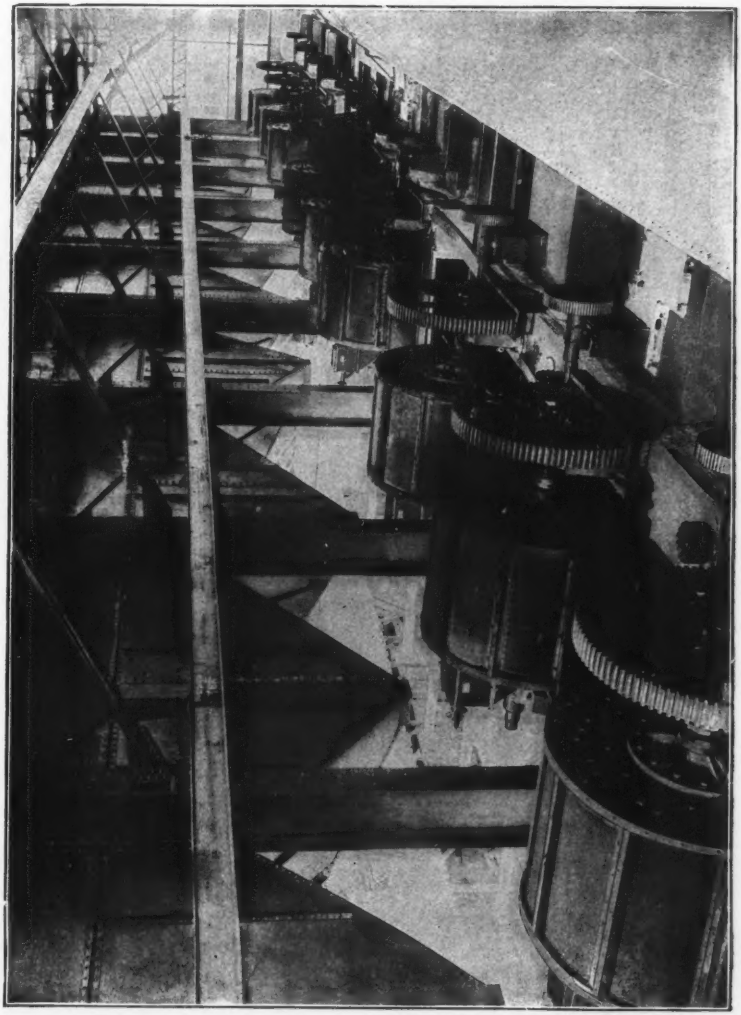


Fig. No. 6. Gates Ball Mills During Installation in a Large Plant.

By courtesy of Allis-Chalmers Co., Milwaukee, Wis.

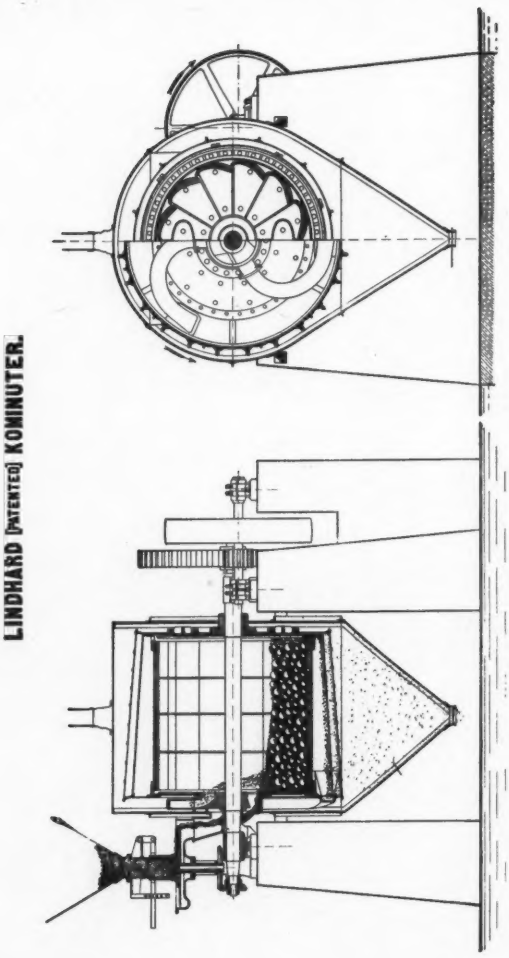


Fig. No. 7. Kominuter.

By courtesy of F. L. Smidth & Co., New York City.

Figure No. 5 shows a transverse section of a Gates Ball Mill while Figure 6 shows a battery of same machines during installation in a large plant in Indiana.

Their capacity on material ground to 20-mesh varies from 12 to 24 barrels per hour according to size.

Hazards.—The hazards of these machines are very mild, if any, by reason of their construction (all metal) and nature of product handled. The speed of revolution at which they run varies from 80 to 120 per minute, so the danger of a hot journal is remote.

Kominuters.—The Century Dictionary defines the word commi-

nute as follows: "To make small or fine; reduce to minute particles or to a fine powder by breaking, pounding, braying, rasping, or grinding; pulverize; triturate; levigate."

The Kominuter is the most recent addition in cement making machinery in the line of low-speed coarse grinders. It combines to some extent features of the ball mill and the tube mill.

In construction it resembles a drum-like section of a steam boiler. The material travels across solid grinding plates from the inlet end to the opposite end and escapes through large openings protected from the action of the balls. The maximum weight of grinding balls is 6,600 pounds. (See Figure No. 7.) The conical shape of the screens forces the material to move from the outlet end back toward the inlet end, where the material rejected by the screens is caught by return buckets and returned to the inlet end of the drum and redeposited by gravity. The buckets empty at the center of the mill around the shaft, and above the level of the balls. It is claimed that it is impossible for any of the material to re-enter the screen without repassing the grinding chamber.

Hazards.—About the same as described for ball mills.

Tube Mill.—Is a pulverizer, and not a coarse grinder.

The tube mill consists of a wrought or steel plate cylinder mounted as a shaft by the attachment of heads so formed as to make trunnions which rest in bearings at both ends. A large gear attached at one end of the tube and a pinion attached to the pulley shaft form the rotating device. The tube is lined with either silex, a flint stone quarried in Europe; ironite, a dense close-grained stone, quarried in United States; porcelain or chilled iron. Silex or ironite are principally used. These tubes may vary from 3½ to 5½ feet in diameter and are from 14 to 22 feet in length. The ends are closed by heavily reinforced cast-iron heads, with hollow trunnions through which the material is fed at one end and discharged at the other.

In operation the mill is filled nearly one-half full with material and flint balls (pebbles) and made to revolve, causing the mass of pebbles and material to tumble over each other, developing in this way an enormous grinding surface capable of reducing material without the use of screens to any degree of fineness, even to an impalpable powder. This also permits a slow speed of rotation—from 22 to 27 revolutions per minute according to size of machine.

It is claimed that 90 to 95% of the product discharged by these machines will pass 10,000 meshes per square inch, if the clinker has had a preliminary grinding sufficient to pass a No. 20 or No. 30 sieve.

Figure No. 8 shows a general view of a tube mill while Figure No. 9 shows a longitudinal section of same. Figure No. 10 shows part of a battery of 18 Allis-Chalmers Tube Mills.

Hazards.—Practically the same as described for ball mills and Kominuters.

Fineness of Mixture.—After its final reduction and when ready to enter the rotary kilns the mixture will run from 90 to 95% through a 100-mesh sieve. I am informed though that at the Lehigh district plants the mixture is rarely crushed as fine as when limestone and clay are used. This is explained by Newberry in the Twentieth Annual

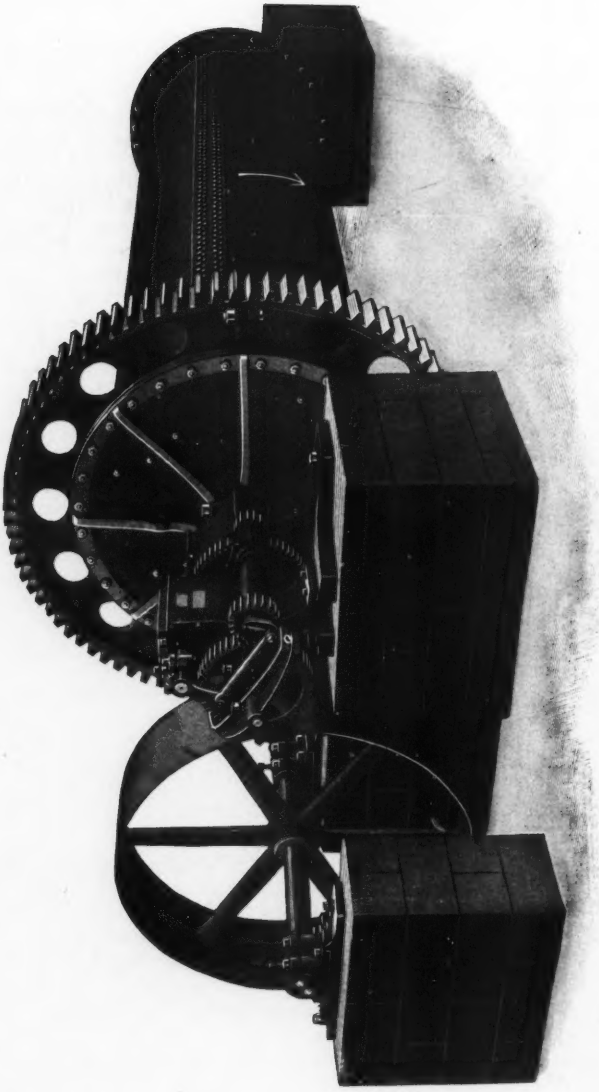


Fig. No. 8. Gates Tube Mill.

By courtesy of Allis-Chalmers Co., Milwaukee, Wis.

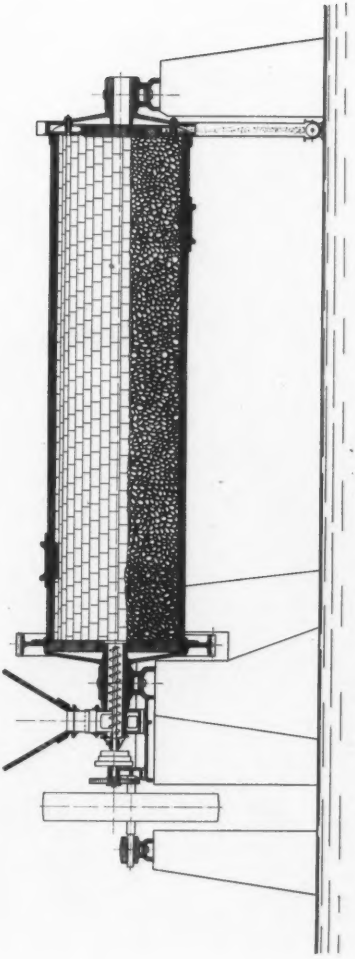


Fig. No. 9. Longitudinal Section of a Tube Mill.

By courtesy of F. L. Smidth & Co., New York City.

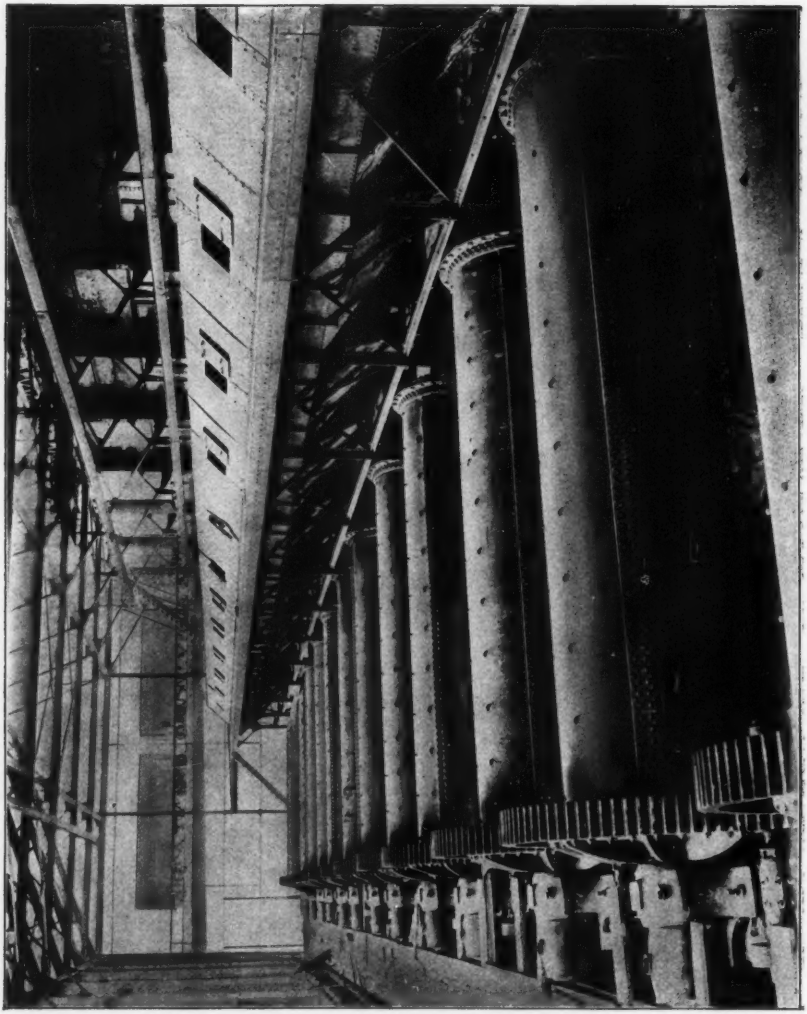


Fig. No. 10. Grinding Room. Showing Battery of Tube Mills.

By courtesy of Allis-Chalmers Co., Milwaukee, Wis.

Report United States Geological Survey, as follows: "An argillaceous limestone (cement rock) mixed with a comparatively small quantity of purer limestone, requires less thorough mixing and less fine grinding that when a mixture of limestone and clay (or marl and clay) is used, for the reason that the coarser particles of the argillaceous limestone will vary so little in chemical composition from the proper mixture as to affect the quality of the resulting cement but little, should either mixing or grinding be incompletely done."

Composition of Mixture.—The cement mixture ready for burning will ordinarily contain about 75% carbonate of lime, or an equivalent proportion of lime oxide, silica from 12.5 to 14.75%, alumina and iron oxide 4.5 to 7%, and magnesia oxide 1.75 to 2.75%.

KILN BURNING.

Rotary Kilns.—After the raw material has been prepared for burning by being properly mixed and reduced and pulverized in the ball and tube mills or Kominuters, as the case may be, it is then conveyed and elevated to Raw Material Storage Bins these being generally located conveniently near one end of the rotary kilns. Figure No. 11 shows an arrangement for supplying raw material from storage bin to rotary kiln, while Figure No. 12 shows the rotary kiln itself. Figure No. 13 shows part of a battery of Allis-Chalmers Rotary Kilns, also elevated raw material storage bins at left of illustration.

The kilns are built of the heaviest character throughout and consist of two main parts (exclusive of stock), viz.: Rotating portion mounted on riding rings the tapered or feed end of which enters the stack, and the stationary firing-hood to which is connected the pipes supplying pulverized coal. All of the running parts of this machine are extremely liberal in proportions and the bearings capable of efficient lubrication and designed for allowance of maximum wear, all of which is necessary by reason of the unfavorable surroundings which prevail.

Rotary kilns are quite similar in appearance to rotary dryers except for being much longer and having no furnace at one end. They are lined with about nine inches of fire-brick and mounted on trunnion rollers. The firing-hood as will be noticed (see Figure No. 12), is arranged so as to be detached from the main cylinder, this for purposes of repairs. The two holes shown in end of firing-hood are for pipe connections supplying the pulverized coal. Figure No. 11 shows the conveyor arrangement for supplying the finely ground raw material to the tapering end of the kiln where same joins the stack, out of which the gases pass. While the material is being fed in at one end pulverized coal under air blast is being introduced at the other. This coal once fired maintains a steady, fierce heat as long as the coal is supplied. As the kilns run continuously until shut down for repairs, it will be readily seen that the most vital part of a cement works is a successful coal pulverizing plant with duplicate machinery in all its parts.

The kilns, as will be noticed, are slightly inclined. The raw material under the fierce heat (2,000 to 3,000° F.) is fused and under the influence of gravity as the kiln slowly revolves finds its way to the

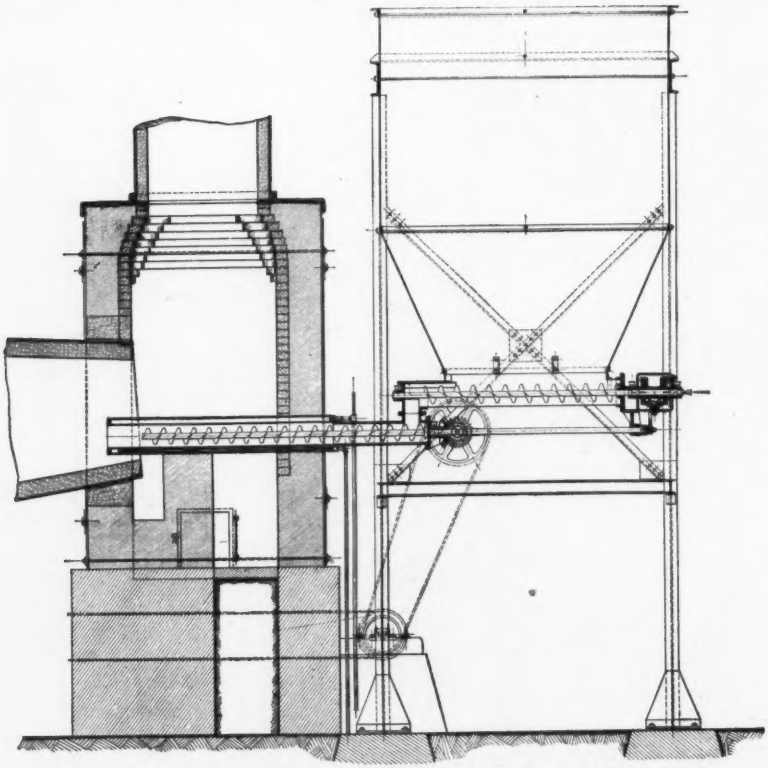


Fig. No. 11. Raw Material Storage Bin.

By courtesy of Allis-Chalmers Co., Milwaukee, Wis.

lower end where it is discharged in the form of a hot "clinker" into metal conveyors which transfer it to the clinker storage pit to cool. In forming the "clinker" the properties composing the mixture are practically melted and united or amalgamated into partially vitrified or crystalized lumps, greenish black in color. In passing through the kiln the material loses about one-third of its weight.

Next to the coal drying and pulverizing process the handling of the "clinker" is considered the most hazardous process. The clinker is discharged from the kilns at almost white heat and falls into a metal chute discharging into metal screw or bucket conveyors.

The earlier rotary kilns were not over five feet in diameter and 40 or 45 feet in length and set at an inclination of three-fourths of an inch to one inch per foot and revolved very slowly. Kilns are now being built with three-eighths of an inch or even less pitch and correspond-

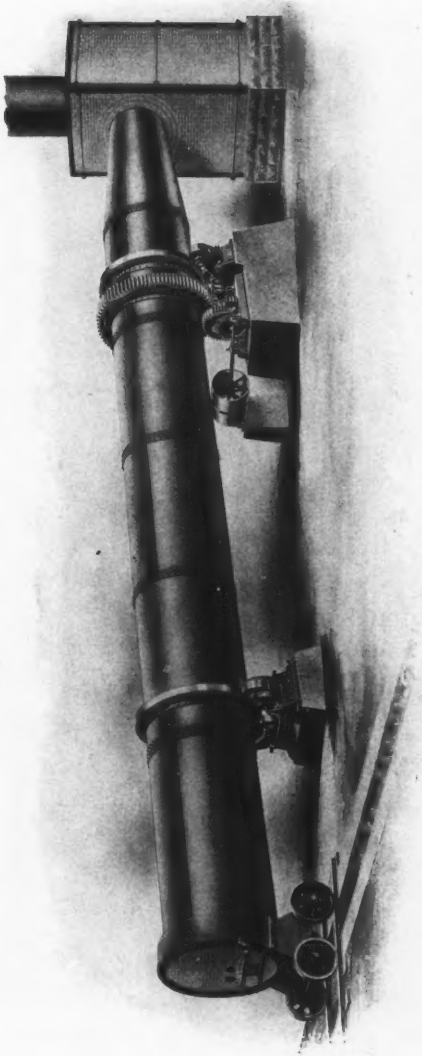


Fig. No. 12. Rotary Kiln with Taper End for Dry Process.

By courtesy of Allis-Chalmers Co., Milwaukee, Wis.

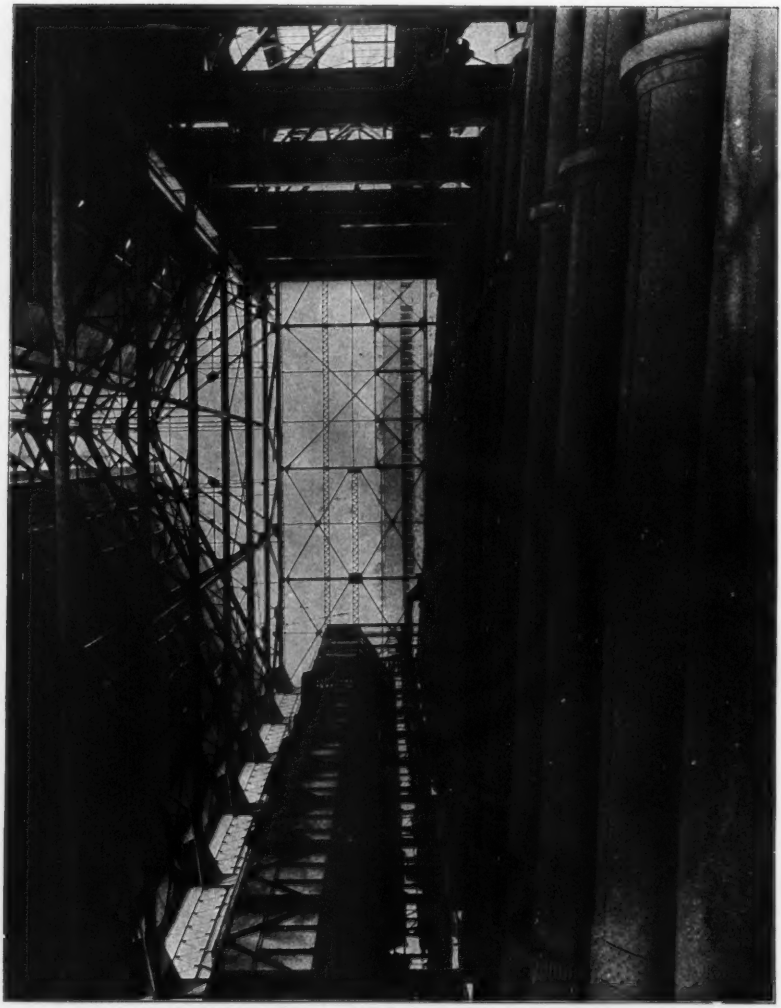


Fig. No. 13. Allis-Chalmers Rotary Kilns.

By courtesy of Allis-Chalmers Co., Milwaukee, Wis.

ingly greater speed of rotation, and in sizes varying from five to eight feet in diameter and from 60 to 135 feet in length. Present kiln practice is leaning toward longer and larger kilns with a reduced diameter toward feed end in order to provide additional heating surface, lower pitch, and greater speed to bring the material more often in contact with flame and hot gases.

I am informed that at The Edison Portland Cement Works at New Village, N. J., the rotary kilns have been constructed with the extraordinary length of 150 feet.

Besides atmospheric air two substances or ingredients enter a rotary cement kiln: (1) raw material in a finely divided state at the upper end, (2) powdered coal at the lower end at which point is also introduced atmospheric air. The resulting product is cement "clinker." Its by-products are sensible heat of the clinker, waste heat of the flue gases including carbonic acid gas, sulphur di-oxide and alkalies (potash and soda).

Mr. F. H. Lewis, a well-known authority, in his paper "The Pursuit of Economy in Kiln Practice," covers this point in detail, from which I quote as follows:—

"The principal raw material used by a cement kiln is atmospheric air. To produce a barrel of cement by the dry method requires 600 pounds of ground rock, 110 pounds of powdered coal and about 2,000 pounds of air. Of this air only about 260 pounds actually contributes to the generation of heat. The balance is inert matter forming part of the gaseous contents of the furnace. * * * * In a rotary kiln the great value of heated gases are badly utilized. Something like 45% of the total heat passes off with the flue gases, while about 12% more passes out at the lower end as the sensible heat of the clinker. If all this waste heat could be utilized it would generate 70% of all the steam power required by a cement plant, or it would heat all the air entering the kilns to an initial temperature of 1,800 degrees and cut the fuel bill in half.

"As other by-products of cement manufacture, for each barrel (380 pounds) of clinker produced, there is given off from the chimney the equivalent of 400 pounds of carbonic acid, 10 pounds of sulphuric acid, and six pounds of potash and soda. These by-products exceed in weight, and if they could be utilized would exceed in value the primary product of manufacture."

Attempts at utilization of the by-products, viz.: the waste heat and waste gases, have been made and quite a few patents taken out. The writer will not go into these details, but refers the reader to the above mentioned article by Mr. F. H. Lewis. (See "Engineering Magazine," September, 1906.) Briefly, they were mostly devices for utilizing the waste heat of the chimney gases also that of the clinker, which at that time did not exceed 8% of the whole. So far as is known nothing is claimed for fuel economy, but the clinker-cooling feature is no doubt of value.

The question of suitable devices for collecting the alkaline vapors in kiln gases has already been discussed by chemical societies. The subject should be one of interest inasmuch as an ordinary ten-kiln

plant discharges about five tons of potash and soda into the atmosphere daily.

Some of the first successful kilns in operation about 15 years ago used crude petroleum as fuel. These kilns were small and required from 10 to 15 gallons of oil to produce a barrel of cement, but the clinker, while of superior quality, was much more difficult to grind than the old-style product.

As has already been stated, finely powdered coal is the fuel most used in the rotary kiln process of making cement. Pulverized coal has been used as a fuel in various ways for many years. Where natural gas is available in commercial quantities no other fuel can compete with it, but the use of fuel oil about doubles the cost of operation as compared with pulverized coal. As the ash from this latter fuel enters the cement "clinker" there are no complications on that score.

The reader is referred to the very interesting article in the December, 1907, and January, 1908, issues of "Engineering Magazine," "Pulverized Coal and Its Industrial Applications," by William D. Ennis, and from which I quote as follows:—

"Pulverized coal is physically interesting. A lighted candle can be plunged into it without other result than the extinguishing of the candle, but if the coal is sifted over a flame from above, in a thin stream, it flashes like gunpowder. A recent British report on bituminous coal dust describes microscopic examination as indicating that the individual particles resemble, not a solid so much as a bubble of explosive gas. Each grain consists of hollow spores having gas within and about it. This dust contains from 25 to 67% of ash and from 18.75 to 30.54% of volatile matter."

The right amount of oxygen is absolutely necessary for the perfect combustion of pulverized coal, and as this cannot be secured by natural draught, forced draught, either by compressed air or by fan or blower, is used. It is generally conceded that about 140 cubic feet of air is required to burn a pound of coal.

The "clinker" from rotary kilns is discharged onto a conveyor which deposits same into an open pit direct or first into metal "clinker" coolers, which are about 10 feet in diameter and 40 feet high. Where coolers are used the clinker is dumped into top by elevators and removed through spouts at bottom discharging onto conveyor extending to clinker storage, where the stuff is allowed to thoroughly cool and well season before being subjected to the finishing grinding.

Hazards of Rotary Kilns.—Without doubt the most pronounced hazard of the rotary kiln is in the method of storing, conveying and burning of the finely pulverized bituminous coal, and already trouble has been experienced along this score, as will be noted later on.

The casual observer would naturally conclude that the cement burning kilns with their great heat (2,800° F.) and that of the clinker discharged constituted the principal hazard about a cement plant. Such is not the case, however, as the very fact of these conditions existing as a rule insures non-combustible construction, not only in the kiln itself but also in everything in its immediate vicinity; a high roof to insure proper ventilation is also essential.

Proper care should be taken to keep all woodwork necessary to construction, such as platforms, decks, galleries, roofs, etc., at a safe distance from kilns and also metal stacks, and the hot clinker should not be stored in cooling bins or pits so as to expose any combustible material; further conveyors for handling hot clinker should be entirely of metal.

The possibility of a coal-dust explosion in the kiln room even where the most approved systems of handling are in use is not remote and liable to happen at any time, either through carelessness or accident on part of employee shutting off the air blast prior to the stopping of the delivery of coal to pipe entering the kiln. Any system which does not provide separate valves for both air blast and coal supply pipes is sure to give trouble sooner or later. It should be noted by the inspector whether this hazard is thoroughly appreciated by the assured and that the necessary precautions have been taken.

COAL PULVERIZING PLANTS.

As has already been stated the fuel used for calcination and which has been found to be most satisfactory and economical is powdered bituminous coal. To burn this successfully, three factors enter the case: (1) uniformity of moisture, (2) uniformity in size of grain, and (3) proper amount of air mixed with the coal to secure perfect combustion.

Ordinarily bituminous coal will carry moisture varying from as low as 4% in summer to 15% in spring and winter and during the rainy season. In winter much of this is in form of ice.

To gain the best results in burning powdered coal there should be no large pieces mixed with same—in other words it should be reduced to grains of equal size that will pass an 80-mesh screen.

By reason of these facts complete coal drying and grinding plants are therefore required and these should be in buildings well detached from main buildings, though frequently they adjoin and are not cut off and form part of the general group.

The lump bituminous coal is stored in coal stock houses from whence it is taken by means of conveyors to hopper located over the coal dryer, the larger lumps first being reduced by a preliminary grinding, if necessary, bringing it down to about nut size, this being accomplished by means of the ordinary roll crusher or cracker. More complete drying is effected by the the reduction of the large lumps as well as better regulation of feed to the pulverizers.

There are other purposes for drying the coal than above mentioned: First, to prevent the material from collecting into lumps or masses, which would seriously interfere with its proper conveyance through the various processes; second, to permit of a perfect feed-regulation at the rotary kiln; third, by keeping the small particles thoroughly separated permits of better combustion within the kiln. Then again, the finely pulverized coal when thoroughly dry is not subject to spontaneous combustion. Storing the coal under shelter will cheapen the cost of drying if kept under cover a sufficient length of time.

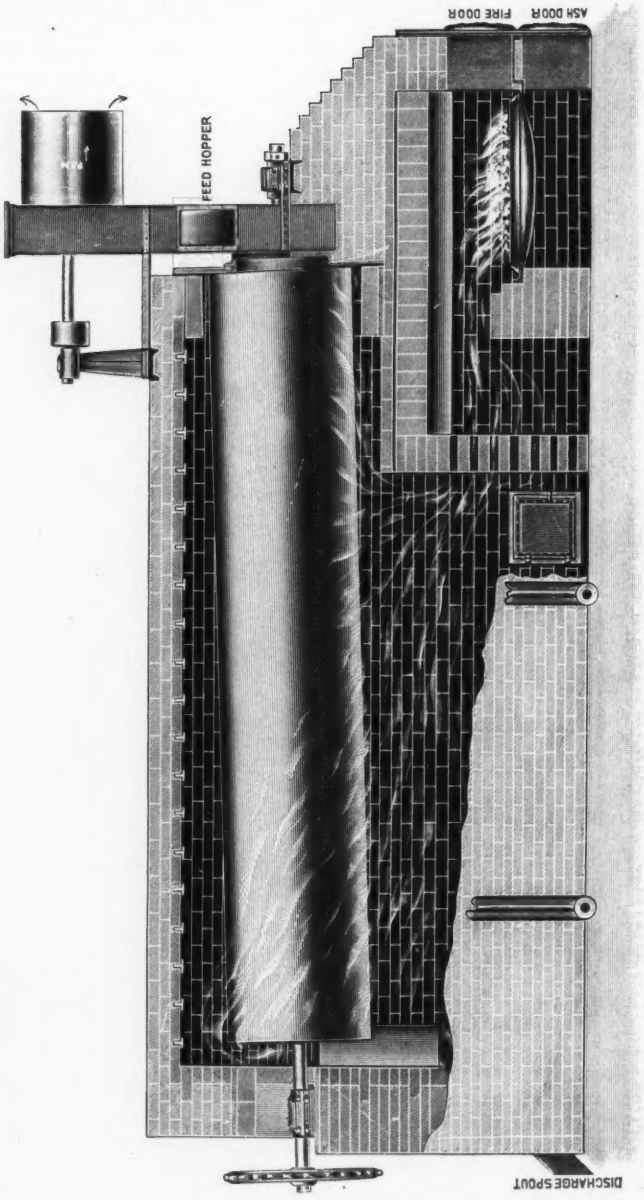


Fig. No. 14. Four-Compartment Dryer Without Dustroom.

By courtesy of The C. O. Barlett & Snow Co., Cleveland, O.

Practically the only method of drying now practiced is by direct fire heat. Steam dryers have been given trial but have been abandoned, although from a fire underwriting point of view have certain advantages in regard to safety; considerations of capacity and economy in favor of the direct heat dryer, however, offset these.

Ordinarily, coal dryers are revolving metal cylinders, not unlike the stone dryers previously described, but generally enclosed, precautions usually being taken to prevent contact of flame with coal.

The more important types of dryers are the Bartlett-Snow, Cummer, Ruggles-Cole, Schwartz-Kopff and American Process Dryer.

Bartlett-Snow Dryer.—In the Bartlett-Snow, four compartment, Direct Heat, Rotary Dryer the cylinder is divided into four sections or compartments with an air or gas space between each compartment, thereby giving a very large outside heating surface. (See Figure 14.) After the heated air has come in contact with the outside of the cylinder, it is drawn through an opening in the arch over the cylinder at the rear end, through a steel flue into the rear end breeching, and through the cylinder, thereby coming in closer contact with the material inside, finally passing out through the exhaust fan and carrying the moisture with it. It will also be noted that at each end, entirely outside the fire walls, are the steel bearing tires resting on steel trunnion rolls.

Figure No. 15 shows same dryer in section, also the travel of hot air and gases from time of entering furnace until entering stack. It will be seen that the gases move in two directions, the plain arrows indicating those outside the dryer while the dotted arrows show the gases inside the cylinder. These machines are arranged in some cases with brick dust room at sides or on top.

The furnace of these dryers is always located at the end where the material to be dried is received and where the greatest heat is needed, and is placed either under the cylinder with fire front at the side, as shown in Figure No. 15, or at the end as shown in Figure No. 14.

These dryers vary in size from four to five feet in diameter and 28 to 48 feet in length.

The Cummer Dryer is a self-contained type of dryer and consists of a revolving steel plate cylinder carried on steel tires and rolls in the usual manner. All wearing parts are accessible and all bearings have sight-feed oil cups. Dryers are provided with disc or exhaust fans depending upon material to be dried. Are made self-contained, semi-self-contained or enclosed in complete brick setting.

The Style "F" Dryer is housed in a steel casing, the side plates reinforced with angles and lined with fire-brick with an air space between plates and lining, while the cover consists of two sheets of extra heavy corrugated iron with three inches of air cell asbestos board between the sheets; cover is bolted to side plates. The relief stack is 18 inches in diameter, equipped with a damper. These dryers are furnished with patent mechanical stokers and it is claimed that perfect combustion can be obtained from slack bituminous coal.

By reference to Figure No. 16 it will be noted that the material is fed into the dryer at one end through the feed spout "A" and is discharged at the rear end.

The heated gases resulting from combustion in the furnace pass

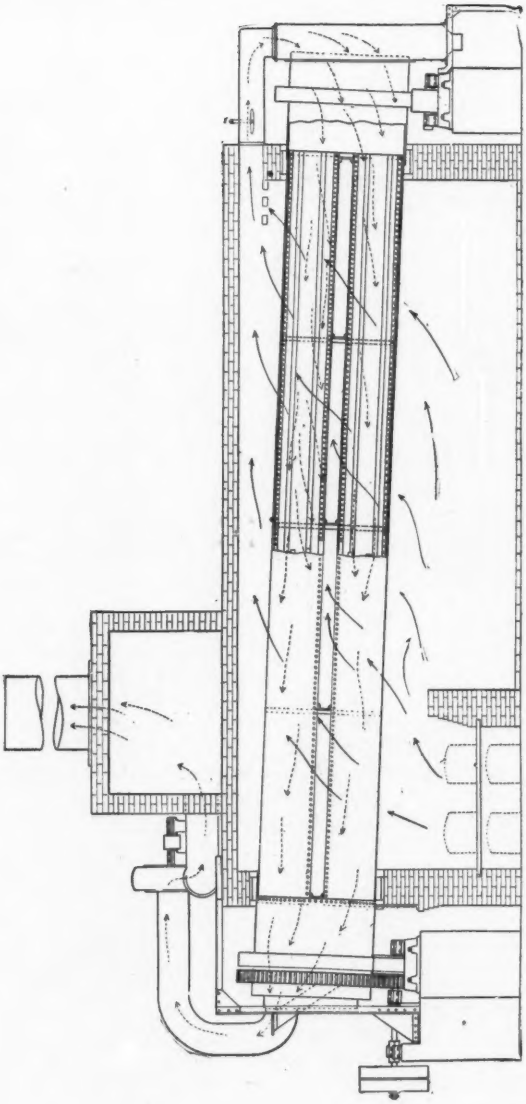


Fig. No. 15. Four Compartment Dryer in Section. Arrows Show Heat Currents.

By courtesy of The C. O. Bartlett & Snow Co., Cleveland, O.

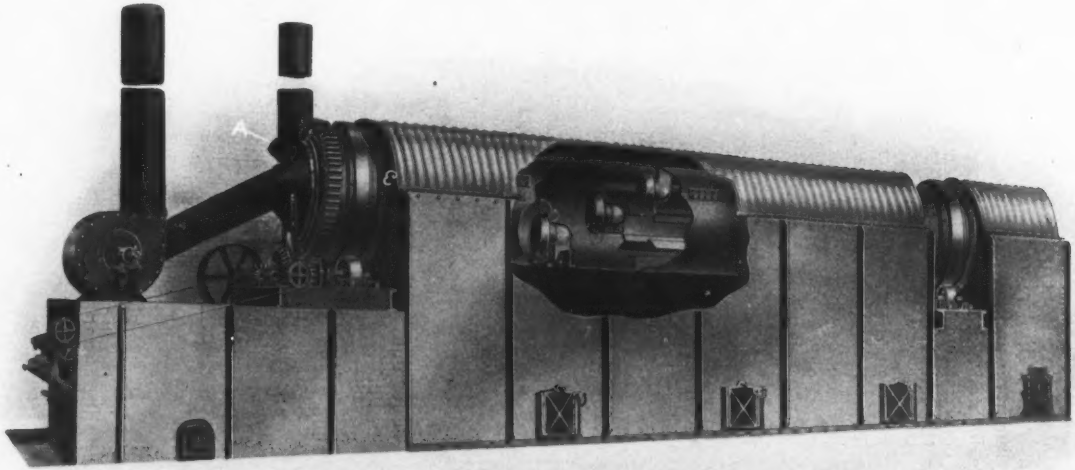
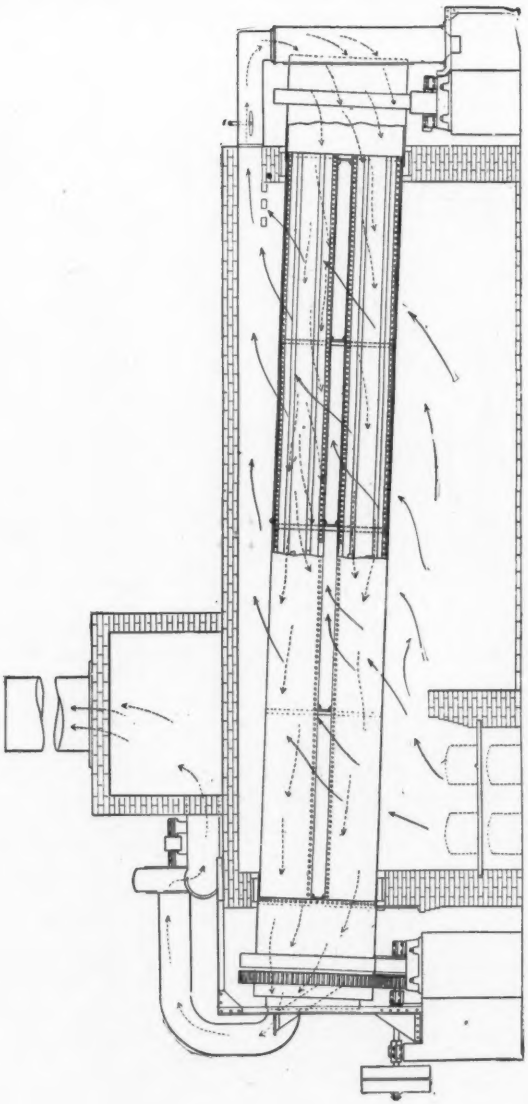


Fig. No. 16. The Cummer Dryer.

By courtesy of The F. D. Cummer & Son Co., Cleveland, O.



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By courtesy of The C. O. Bartlett & Snow Co., Cleveland, O.

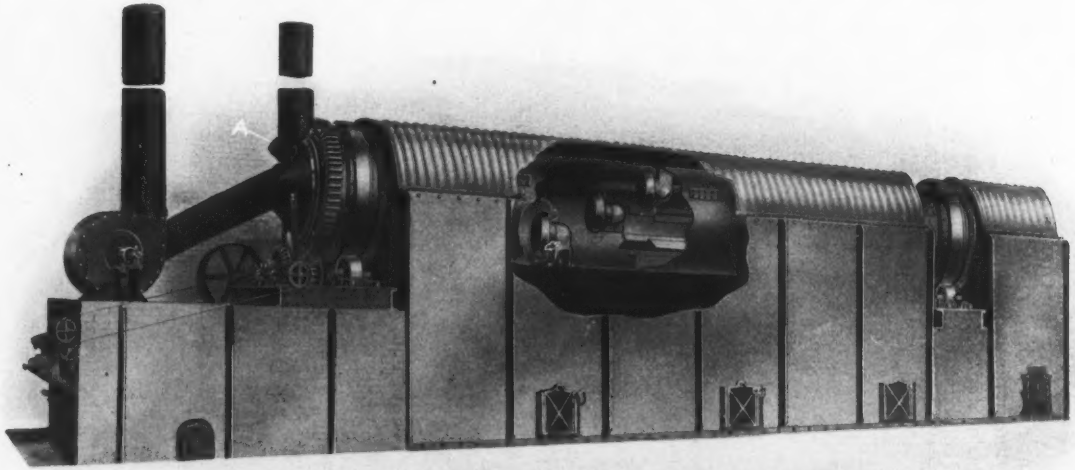


Fig. No. 16. The Cummer Dryer.

By courtesy of The F. D. Cummer & Son Co., Cleveland, O.

into a large commingling chamber which extends the entire length of the dryer cylinder. This cylinder, which revolves slowly, has a great many large square openings in it, each of which is covered with a cast-iron hood or cap as shown. A sufficient number of hoods are put into each cylinder to allow about three-fourths of the heated air and gases that are required to enter the cylinder. The balance of the heated air and gases enter the cylinder through the rear end.

The fan, which is located at the front or feed end of the dryer, draws the products of combustion from the furnace into the commingling chamber, also air through the registers in the side walls of the dryer which reduces the temperatures toward the rear end of the dryer cylinder. The same fan draws the heated air and gases at different temperatures from the commingling chamber into the cylinder through the hoods, in direct contact with the material being dried. The highest temperatures are through the front hoods in contact with the material as it enters the cylinder. The revolving motion of the inclined cylinder causes the material to travel toward the rear. The last five feet of the cylinder has no hoods, but the material while passing through this section comes in contact with the heated air and gases which have not entered through the hoods, and which amount to about 25% of the total volume. The air, gases and moisture pass into the atmosphere from the cylinder through the fan. It is claimed for this machine that for each pound of good slack bituminous coal as fuel 10 pounds of moisture will be evaporated.

These dryers are made in different sizes with capacity of 50 to 350 tons of coal per each 24 hours. It is claimed that coal can be dried so as to contain less than ½% of moisture, and be not heated in the drying process above 100° F.

Ruggles-Coles Class A Dryer.—(Not illustrated.) This dryer consists of two shells. The outer cylinder is made of heavy steel plates, as is also the inner shell or flue, and both are connected together by heavy cast-iron arms, riveted to both cylinders so as to hold the two shells rigidly together.

The inner cylinder, at the head or feed end is extended beyond the outer cylinder and, passing through the stationary head, is connected with the hot-air flue from the furnace, said flue being lined with fire-brick. At the discharge end is a head riveted to the shell. The cylinder is supported on two steel tires resting on light bearing wheels. The exhaust fan is placed where most convenient, generally on top of the furnace.

The furnace is built independent from machine and located where most convenient, although placed generally at head of dryer.

The heated air from furnace passes through the inner cylinder and returns between the outer and inner cylinders to the fan. The material is fed into the dryer through a spout in the stationary head which leads to the bottom of the outer cylinder. Through aid of flights on the inner cylinder, the inclination of the machine and the revolving motion, the material during this operation is continually dropping through the current of heated air, which is travelling from the discharge or dry end of the machine, to and out through the fan at the head or wet end. It is claimed in this type of dryer that the outer

shell is cool at all times and therefore very little heat is lost through radiation.

American Process Co-Dryer is of the direct heat and direct contact type. It consists of a cylindrical steel shell, provided on the interior with longitudinal shelves. The cylinder is slightly inclined and mounted and operated in the usual manner, and connected at one end with a furnace. (See Figure No. 17.)

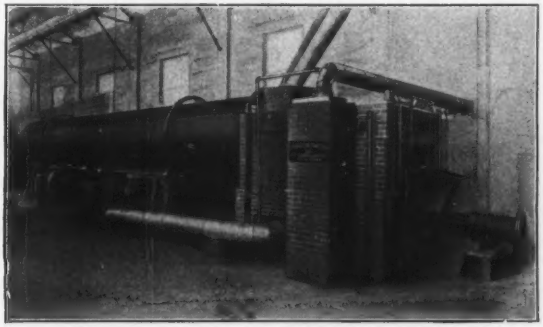


Fig. No. 17. American Process Company Dryer.

By courtesy of American Process Company, New York City.

The material to be dried and the furnace gases enter the shell at the higher end; the material falling to the bottom of the dryer is caught by a shelf, elevated to almost the highest point of rotation and is then showered through furnace gases. Figure No. 18 shows a sectional view of the furnace end of this dryer.

Coal Grinding and Pulverizing.—After coal has been dried it is conveyed to metal storage hoppers from whence it is discharged by gravity to the grinding or pulverizing machines. These are usually Kominuters, or ball and tube mills, although Lehigh-Fuller and Griffin mills are sometimes used. These machines have already been described to some extent. After passing through the mills the ground coal is usually delivered by means of screw conveyors and elevator to the coal magazines, generally located in front of discharge end of rotary kilns.

The grinding room of the coal plant is usually very dusty and a thick accumulation of powdered coal settles over everything in the room not in motion.

Hazards and Conclusions.—Under any circumstances, the storage and handling of bituminous coal is attended with more or less fire hazard. Particularly is this true with the low-grade coals running high in volatile matter, which when pulverized present a still greater increase in hazard.

The processes of drying and pulverizing bituminous coal should

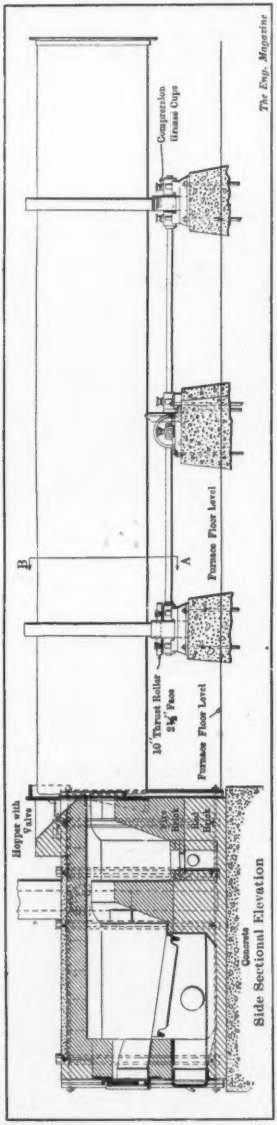


Fig. No. 18. Showing a Sectional View of the American Process Company's Dryer.

By courtesy of American Process Company, New York City.

be conducted in a separate, well-detached building of non-combustible construction if possible, and proper precautions taken against the possibility of dust explosions. The main storage supply should be in non-combustible sheltered bins of minimum capacity, properly ventilated. The tunnel conveyor system for transferring the coal to the dryers is preferred, as by this arrangement coal can be removed from the bottom of the pile first, although there is a possibility of carrying coal which has become fired through spontaneous combustion, to the dryers.

The pulverizing and drying rooms must be thoroughly ventilated and no open lights or fires permitted. Electric motors preferred for driving machinery and should be located in separate compartments as well as controlling switches, etc.

Detailed plans and specifications showing general arrangement of coal grinding and drying machinery should be submitted to underwriters having jurisdiction.

Under no circumstances is it recommended that the products of combustion be allowed to come in contact with the coal to be dried. Some recommend this and I am informed that quite a number of plants are thus arranged. Already there have been quite a number of accidents from this cause in which lives were lost.

A characteristic coal mill explosion [March 2, 1903—Editors.] in New Village, N. J., caused by the ignition of pulverized coal at the Edison plant, killed six men and burned five others, perhaps fatally, besides injuring a score of others and destroying the coal building. It is supposed that the pulverized coal in bin fired spontaneously and some of the burning fuel was carried by the conveyor (automatic) into the blower house. The atmosphere of the blower house being charged with coal dust an explosion was the result.

On August 19, 1900, an explosion in the plant of the Nazareth Cement Co., Nazareth, Pa., caused a loss of $16,000, while on November 26 of the same year $40,000 damage was done to the Martin's Creek Portland Cement Co. (then known as William Krause & Sons), Martin's Creek, Pa. The Dexter Portland Cement Co., Nazareth, Pa., and the Alpha Portland Cement Mill No. 1, Alpha, N. J., had similar experiences the same year.

I learn that the laws of England do not allow any coal dryers where the products of fire come in contact with coal to be dried, and engineers in that country had already predicted trouble with disastrous results in this country before the above mentioned accidents occurred.

FINISHED GRINDING.

Ball and tube mills also Kominuters are used for grinding the clinker into finished cement as well as preparing the raw material for the kilns. Usually the same number of machines necessary to prepare the raw material are required in pulverizing a given quantity of clinker into finished cement. Griffin mills and Fuller-Lehigh mills are also used.

The "clinker," which has been allowed to cool and season in the storage pit, is conveyed to the finished grinding department by the usual methods (screw and belt conveyors and bucket elevators) and is first passed through clinker crushing rolls, where the clinker is reduced

to about the size of peas. It is then elevated to bins located over the Kominuters, ball or other mills as the case may be. As in the grinding of raw stock for kilns the clinker after going through crushing rolls is first ground to 20-30 mesh in ball mills or Kominuters and afterward to 100-mesh in tube, Fuller-Lehigh or Griffin mills.

The question of grinding by separation is at present probably receiving more attention in Portland cement plants than any other feature, both from the cement manufacturers themselves as well as from the makers of grinding machinery. There are at present several successful methods in operation, such as passing material over a screen after each step in the process of reduction, the separation being effected by the coarse and fine stuff passing together over the screen; another method is by a system of wind separation; besides these are numerous mechanical separators, similar to those used in flour mills.

It is not necessary nor practicable to describe in this article the various methods and treatments of separation which are being used to suit different conditions. A very interesting paper by Mr. F. H. Lewis, entitled "Grinding by Separation," and which covered this subject in detail, appeared in January, 1907, number of "Engineering Magazine," to which the reader is referred.

STORAGE AND SHIPPING.

Storage of finished cement in warehouses especially designed for purpose, and bagging, barreling and shipping the product conclude the operations, and while these do not involve any extra hazardous processes the companies writing these classes of risks have probably experienced greater losses in finished stock warehouses than any other portion of the plant, with possible exception of the coal pulverizing mills. This may be explained by two factors: First, prevailing majority of warehouses being of inferior construction, having light frame roofs supported upon wooden trusses, in turn supported on wood columns, resting on wood storage bins; second, little or no salvage on stock having been subjected to water damage.

An experienced cement manufacturer once remarked to me that a fire which had gained any headway in a finished stock warehouse would be better if left alone as long as it did not endanger the other buildings. The stock at least would be left if no water was thrown on same, while if water was used the building might be saved but the stock in all probability would be worthless. There are differences of opinion about this, however, some claiming that the stock would only be damaged on the surface only when in bulk, while others claim it could all be used over again.

CONCLUSIONS AND RECOMMENDATIONS.

In designing most of the Portland cement plants, there has been a tendency toward compactness which has resulted in congestion of buildings, thereby bringing a number of processes under one roof.

The model cement plant should not only consist of buildings of superior construction, but they should also be so arranged as to secure

separation of processes as well. This would also tend to lessen some of the problems of rate makers.

Exclusive of the usual adjuncts such as office and laboratory, repair shops, power plant, etc., the first group should consist of the crushing plant; second, the stone drying plant, inclusive of weighing and mixing plant if necessary; third, the raw material storage and grinding plant; fourth, the burning or calcining plant and clinker storage if desired (cut off from each other); fifth, the coal storage drying and pulverizing plant (cut off from each other); sixth, the finished grinding plant; seventh, the cement storage and shipping plant.

The construction should be as near fire-proof as circumstances will allow and all structural members at least of non-combustible material. It is the writer's opinion that steel skeleton frame construction, covered with corrugated iron or cement on expanded metal makes an ideal shelter for risks of this class. In plants where the majority of the construction is combustible with no separation of processes there should be introduced as many fire stops, such as blank, parapet, brick walls, as possible.

Where it is necessary to use wood in construction same should be thoroughly whitewashed.

All stacks, funnels and flues for carrying off products of combustion should be of metal, safely arranged, and properly ventilated where passing through combustible roofs or partitions. Stacks should be well braced and of sufficient height to induce proper draught.

All chutes, elevators and conveyors for handling hot material from rock dryers as well as hoppers and bins for storage of same should be of metal with ample clearance from all combustible material. Conveyors for handling hot clinker from rotary kilns are of necessity of metal, but proper precautions should be taken about running same in close proximity to woodwork.

The clinker storage pit or other receptacles into which the hot clinker is discharged for cooling, should not only be fire-proof, but must have no combustible material in proximity to them.

The coal storage, drying and pulverizing plant should be only one story in height and not only of fire-proof construction well detached or properly cut off from the main buildings if adjoining, but there should also be a separation of the storage, drying and pulverizing processes. Especially should the furnaces for the dryers be outside or in separate room from pulverizing. Conveyors to the kiln building as well as shelters for same, also receiving bins and hoppers for storage of powdered coal, should be of metal. There should be no open lights of any kind allowed in the pulverizing room. Proper facilities for perfect ventilation should be had. The capacity of the coal storage bins should be as small as possible and coal handled by tunnel conveyor system so as to be taken from the bottom of the pile. Electric motors for driving machinery, especially when of the direct current type, should be in separate room for purpose, cut off.

Ground coal should not be stored in bulk in any part of coal grinding plant. Spontaneous combustion in the powdered coal should be guarded against by keeping same perfectly dry; no large quantity should be allowed to accumulate.

The coal dryers should be of the most approved type and their construction as near fire and explosion proof as possible.

All pipes conveying powdered coal whether to storage hoppers or to kilns should be provided with individual gates or valves as well as all air-blast pipes connected therewith. Failure to shut off supply of powdered coal before shutting off the air blast might cause an explosion by fire from the kiln connecting to coal hopper, which as a rule is located only a few feet distant from same.

All screw conveyors whether for moving raw stock, coal, clinker or finished cement, should be enclosed in metal casing or run underground in concrete tunnels; they are subject to friction heat when they become choked with material.

The clinker coolers, also storage pit, should be properly detached from buildings of combustible material; necessary precautions should be taken to guard against hot "clinker" from storage pit or coolers entering the finished grinding building.

Finished stock storage warehouse and shipping building should be of superior construction and detached beyond exposure distance from other portions of the plant. Shelter for conveyors from finished grinding building to warehouse, when overhead as in some plants, should be of non-combustible construction, and arranged with fire stops at each end.

All minor processes such as coopering, bag cleaning and repairing, repair shops, etc., should be in well-detached buildings.

In conclusion I might call attention to the fact that while there are certain plants of this class which from their arrangement, construction, separation of processes and protection features form desirable risks, there are many others, however, that are not desirable, but which could be made acceptable by adopting as many of the above suggestions as are applicable.

F. E. MacKNIGHT, *Chief Inspector,*
The South-Eastern Tariff Association.

December 20, 1907.

A Method for the Classification of the Hazardous Properties of Certain Liquids.

PART I.—INTRODUCTION.

Various writers on fire risks have from time to time classified systematically many hazardous liquids according to their flash points, burning points, and the explosive range of their vapor-air mixtures. It appears that no system, however, has been advanced which takes into consideration every property of a hazardous liquid that has a bearing on the fire hazard, and assigns to each property a relative value in accordance with its importance, taking the sum of these composite values as indicating the class to which the liquid in question belongs as indicating its relative hazard. In the various investigations that are conducted at the Laboratories, we have felt the urgent need of some such method for classification. The results of our investigation of the subject lead us to the belief that such a system is not only possible but practical. The object of this paper is to set forth some suggestions in this direction in a preliminary way, in order that we may benefit by criticism and comment from members of the National Fire Protection Association.

BASIS OF THE METHOD.

All hazardous liquids have certain properties in common. These common properties differ from each other in greater or less degree. Hazardous liquids also possess properties which are characteristic individually and characteristic of a class. It therefore follows that when we know these properties of a liquid, we know how it will behave under certain conditions. If we know certain properties of a liquid we can indicate its chemical conduct and its conduct relative to fire. We know how liquids have acted under the various conditions of use and accident from reports of experience in practice. We can determine the properties of these liquids; we can reproduce these conditions on an experimental basis; we can deduce which properties constitute the danger. Some of these properties will in a degree be more hazardous than others, and by assigning a relative value to each we arrive at a basis for our rating.

Hazardous Properties.—The principal characteristics indicative of the hazard of liquids of this class may be considered, irrespective of their relative importance, to be,

1. Range of vapor-air explosive mixtures.
2. Ignition point.
3. Flashing point.
4. Combustibility (Burning point).
5. Vapor density.
6. Volatility.

7. Chemical activity or hazards in combinations.
8. Ability as a factor in spontaneous ignition.
9. Ability towards leakage.
10. Ability as a corrosive agent.
11. Resistance when burning to the extinguishing action of water.
12. Violence of vapor-air explosives.

Let us briefly define what we mean by some of these terms.

Explosive Qualities.—This term is here used in its broadest sense. In the consideration of the explosive range of vapor-air mixtures we know that in certain proportions the explosions will be very violent, while in the proportions bordering on the limits of the range the explosions will be less violent. As the boundary between what is popularly termed an "explosion" and what may be termed "quick burning" is reached, loud noise and great pressure may cease, but the term as we use it is intended to include the widest limits in which phenomena of this nature are observed.

Ignition Point.—The temperature at which a vapor-air mixture will take fire is evidently an essential factor in determining hazard. The flash point does not tell us what the ignition point is, because the temperatures of the flames used in flash point determinations are relatively high. The ignition point of many liquids is below the temperatures of flames.

Flashing Point.—Much misconception seems to exist concerning this feature. Its value and limitations are made evident by considering exactly what the term means. The flashing point of a liquid is the temperature at which it gives off sufficient vapor to form an ignitable mixture with the air contained in the vessel used. If we vary the pressure, the dimensions of the vessel, the quantity of the liquid, the opening in the explosive chamber, the rate of heating, we vary the results. In intelligently comparing results we must know all these factors. To secure uniformity of results it therefore appears necessary to adopt a special form of apparatus. In this method we will be guided by the Underwriters' Laboratories' Standard tester, which is practically identical with the Elliot tester, also known as the New York State Board of Health tester. It is a covered tester and gives results comparable with those used in the past by the fire insurance interests.

That the flash point indicates to a large extent the hazard of a liquid must be admitted. That it indicates explosive qualities is understood. That as a rule the most explosive vapor-air mixtures are from liquids having the lowest flash points is also known. This being true, it may be asked, "Why not do away with other tests and form the scale according to the flash point alone?" On second thought it will be seen that in the case of liquids of flash points near ordinary temperatures we cannot decide their relative hazards on the flash point basis alone. The volatility (evaporation) of the liquid is not defined completely by the flash point. It is only indicated. A liquid may give off vapors, but not in the right proportion, for an explosive mixture in a certain vessel at a certain temperature. Nor does the flash point tell us anything about the character of the mixture. For these

and other reasons it appears necessary to consider the explosive qualities of a vapor under conditions approaching those met in the field. We can take a vessel and allow a liquid in it to evaporate at room temperature, just as it would under actual conditions, and bring a spark into the mixture formed, and we get results—the importance of which I do not believe any one can deny.

By considering results obtained under various conditions in connection with the ignition and flash point of a liquid, we can determine its explosive qualities.

Combustibility (Burning Point): (Fire Test.)—The burning point of a liquid is the temperature to which it must be heated in order to give off vapors which when ignited will burn continuously. It has been proposed at various times to do away with the flash point and use the burning point as a criterion. In most cases the burning point is several degrees higher that the flash point. However, if a liquid is spilled when at the flashing temperature and ignited, the combustion of vapor will generally raise the temperature to the burning point. The burning point then cannot displace the flashing point for all purposes. What the burning point really tells us is how combustible a liquid is. No one would attempt to classify a liquid without this knowledge.

Vapor Density.—The importance of the vapor density in considering hazards is well known. If the vapors are heavier than air they will fall, and may accumulate in vessels or a closed space and remain for some time, or they may flow to a distant fire and ignite. By considering the vapor density in connection with the flash point we gain valuable information. The lower the flash point the more dangerous the vapor becomes, on account of its density if it is heavier than air. If we did not rate the vapor density hazard in reference to the flash point, a liquid like carbon tetra chloride, the vapors of which are very heavy, would be placed in a false position in the scale.

Volatility.—How rapidly an inflammable liquid will give off vapors at ordinary temperatures and when heated are very important questions. The boiling point will indicate this property at higher temperatures, but it is also important to know the relative volatility at ordinary temperatures. The relative vapor pressure of a liquid at a temperature of 68° F. will indicate its comparative tendency to evaporate.

In order to define vapor pressure, let us consider for a moment the theory of evaporation. In the gaseous state the molecules are in motion. This is also true of the liquid state. However, in the liquid state the energy of the molecules is unable to overcome their mutual attraction. Moreover, each molecule does not have the same kinetic energy (that is, motion which is temperature). Some are above the average, some below it. When the former strike the surface of a liquid freely exposed, they escape (evaporation), and as we would expect, the temperature of the liquid falls. The pressure thus exerted by the molecules of a vapor is the vapor pressure.

The boiling point of a liquid then is the temperature at which the vapor pressure is equal to the atmospheric pressure. By taking into consideration the vapor pressure of a liquid in connection with its

inflammability, we learn its relative hazard in this respect. We can get much more accurate information as to the tendency to evaporate this way than by allowing liquids to stand in the open and noting how fast they evaporate. Drafts, variations in temperature and in the size of the vessels used would tend to vitiate the results.

Items 7 to 12 inclusive, referred to above, do not seem to need definition. Their importance is evident and they will each be taken up in the classification which follows:—

COMPARATIVE VALUE OF HAZARDOUS PROPERTIES.

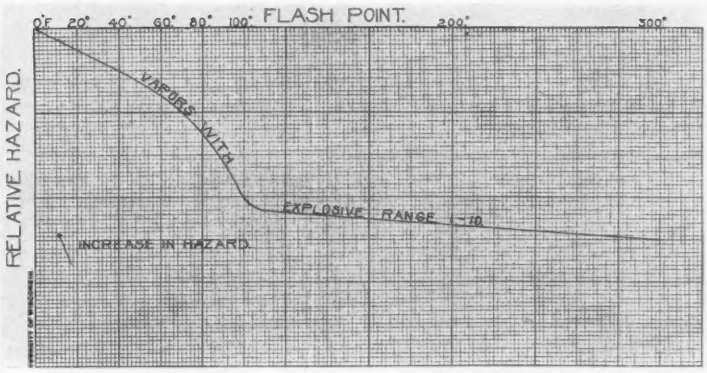
We must endeavor to avoid as far as possible assigning arbitrary values to these different properties. On the other hand, when curves indicating the relative value are drawn, limitations manifest themselves, which aid in scientifically determining the values.

Before considering these values it is necessary to determine the number of classes that we care to use, and also what liquid is suitable for a standard. As the system is to determine the relative hazard, not the absolute hazard, it is unnecessary that Class 10 should be ten times as hazardous as Class 1. In fact, there appears to be no necessity for going into the laborious task of determining *exactly* how many times more hazardous carbon disulphide is than paraffine oil. If we can say that Carbon Disulphide and other liquids belong to Class 10 and Paraffine Oil to Class 1, and some other substances to Classes 5 or 6 and so on, and that Class 10 is *at least* ten times more hazardous than Class 1, our system will obviously be practical in this respect. If we adopt the figure ten (10) for Ether and one (1) for Paraffine Oil, we can do this. By taking ten (10) as the standard and working it out in every conceivable way, we find that we have a range that more than covers the needs in this respect. For these reasons, it appears that ten (10) classes will suffice for a practical scale.

In order to make the scale comparative, we must select some liquid as a standard. The behavior of gasolene is so well known by fire insurance men that it is the first to suggest itself. However, gasolene is not a pure and simple substance, and varies in properties according to its specific gravity. Ether is a compound also well known and is as hazardous as gasolene. Besides, it is an "individual" liquid and is very suitable for a standard, as will be seen later. Ether possesses all the hazardous properties enumerated above, except the exceptional one of spontaneous ignition. We will therefore call the hazard of Ether ten (10).

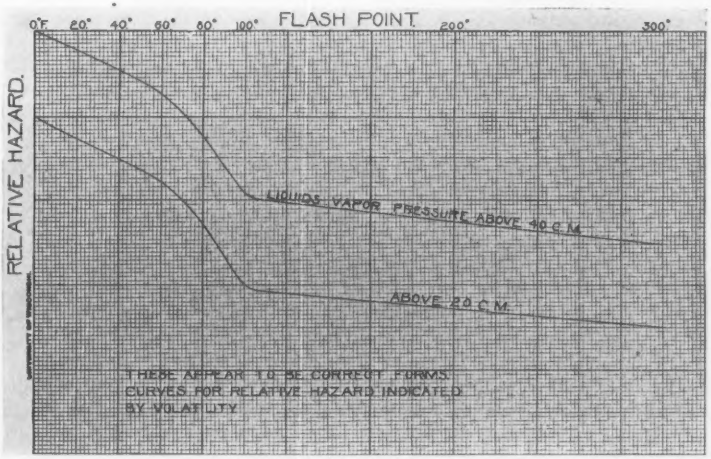
The next step is to assign values to the hazardous properties of ether. If this is done proportionally, the sum should equal 10. Then a liquid having the same hazardous properties as ether will also fall in Class 10; those having less will fall in Class 9, and so on. In order to avoid fractions, we shall make the sum of the numerical values of the properties of ether equal one hundred (100), and divide the result in every case by 10.

The value given the explosive qualities of ether, depending upon the flash point and ignition point, must take the form of curves so that these properties in other liquids can be rated proportionally. To illustrate, our curve is something like the following:—

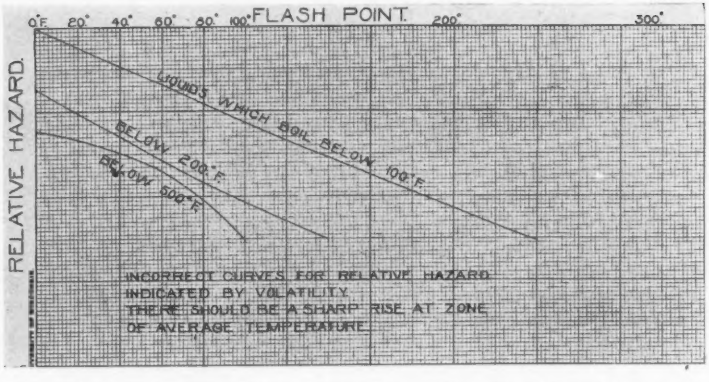


It will be noted that the lower the flash point, the greater the value of the explosive characteristic.

Starting a curve for vapors with an explosive range 1-10 at 300° F., the hazard gradually increases as the flash point gets lower until we get to 100°, when the curve changes and the hazard rises rapidly until we are below the zone of average temperature, then the hazard gradually increases again to 0°. Curves will be shown something like this one for vapors with explosive range 10-20, and so on. Curves are also drawn for vapor pressure as shown.


0° F. 20° 40° 60° 80° 100° FLASH POINT. 200° 300°
RELATIVE HAZARD.
LIQUIDS VAPOR PRESSURE ABOVE 40 C.M.
ABOVE 20 C.M.
THESE APPEAR TO BE CORRECT FORMS.
CURVES FOR RELATIVE HAZARD INDICATED
BY VOLATILITY

We are also showing some incorrect curves.


0°F. 20° 40° 60° 80° 100° FLASH POINT 200° 300°
RELATIVE HAZARD.
LIQUIDS WHICH BOIL BELOW 100°F.
BELOW 200°F.
BELOW 500°F.
INCORRECT CURVES FOR RELATIVE HAZARD INDICATED BY VOLATILITY.
THERE SHOULD BE A SHARP RISE AT ZONE OF AVERAGE TEMPERATURE.

By taking the properties of any hazardous liquid and consulting the curves for the hazardous properties, we can get a sum which will indicate the class to which the liquid belongs as indicating its relative hazard.

Having put the idea of the method before you, we will in the next issue consider at length the comparative value of the hazardous properties and show all the curves and the class to which certain liquids will fall rated accordingly.

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The Underwriters' Laboratories, Inc.

Cement Plants.

Before attempting to give consideration to the various processes and fire hazards incident to the manufacture of cements, and without entering upon the field of historical data of this industry, interesting as it is, it appears proper to devote some space to the recital of the remarkable growth of the Portland cement industry since 1890, when the large demand for this material in construction work stimulated activity in the trade to place domestic production in competition with that of foreign manufacture, while at the same time the success attending the use of the rotary kiln in place of those of intermittent action and the general advance in the science of manufacturing cement served to interest capital, and many new plants were established. The list of new ventures since that date is remarkable for its number, and the future holds promise of continued and profitable increase.

In 1891 the total consumption of Portland cement in the United States is stated at 3,443,126 barrels, of which domestic plants produced only some 13%; in 1899 the total net consumption is stated as being 7,650,382 barrels, of which domestic concerns furnished 73.9%, while the official figures for 1906 show domestic production of Portland cement to have reached 46,463,424 barrels, of which only 8.5% is credited to wet process plants. This remarkable increase is not an evidence of overproduction, but is indicative of a healthy growth in the demand for the material, due to the ever broadening uses to which Portland cement may be put, and to its superiority over natural or Rosendale cement under all conditions where cement may be used to advantage. The displacement of Rosendale cement by Portland has become so widespread and general as to cause a marked reduction in the production of the former, many of such plants having been dismantled and abandoned, while in other instances they have been and are being converted into the Portland class at great expense due to the abandonment of old machinery and appliances and the substitution of new.

The Portland cement industry is a growing and prosperous one; the demand for high-grade material is practically without limit and the supply of standard grade Portland hardly equal to the demand, hence, new plants will be established to meet the needs of the trade, and as in almost every state of the Union there may be found large deposits of limestone and clay or shale suitable for the production of standard Portland cement, the industry may be expected to expand in response to the growing demands, and under proper conditions as to construction and equipment the class should prove profitable as commercial ventures.

The initial cost of a complete Portland cement plant is high, it being stated on good authority that in a wet process plant producing 1,000 barrels per day, the investment for the plant and equipment, without provision for working capital in reserve, will range from $50,000 to $60,000 per rotary kiln, while a modern dry system plant and its equipment will range from $85,000 to over $110,000 per kiln,

where the output runs as high as 1,500 barrels per day; doubling the output is said to reduce the cost of production by about 10 cents per barrel. While the initial cost is high, the margin for profitable operation appears to be wide in view of the fact that in 1900 the cost per barrel of cement made by the wet or marl process averaged 66 cents and under the dry (limestone and clay) process the average was 55 cents, while the quoted market price for standard Portland in large quantities was about $2.00 per barrel. Under improved methods of production since that date the cost price has doubtless been appreciably reduced, while the value per barrel produced in 1906 seems to average about $1.13 including all grades, good, bad and indifferent in quality. In view of the fact that a plant of less than four kilns capacity would find it difficult to profitably meet present competition, it does not seem probable that reckless expansion in the number of doubtful ventures is to be apprehended in the near future.

The classes of cement which are to be considered in the following remarks, while differing in many particulars as to individual characteristics, are each known as "hydraulic cements;" a general and inclusive definition of the class known commercially as "Cement" is as follows:

Specifically, cement is a mortar or material which is capable of solidifying when in contact with water, without change of volume or notable evolution of heat. It differs from lime in that the latter crumbles, expands and gives off heat when exposed to water or excess moisture. A proper proportion of clay mixed with lime has a tendency to check crumbling and the evolution of heat and to bring about that quality of hydraulicity which characterizes cement.

Included within this broad classification the most important and valuable of the hydraulic cements is that known as "Portland," which is an artificial cement produced from the intimate mixture of limestone or marl (carbonates of lime) and clay, with limited percentage of alumina and silica; each of these ingredients being accurately proportioned in the raw stock mixture before being burned. In some localities there are to be found natural deposits of so-called "cement rock" wherein the proportions of lime and clay are such as to render it fitted for the production of Portland cement without additions of any kind. Blast furnace slag is also used, in conjunction with lime, to produce Portland cement, and this combination seems to have a promising future before it.

Second in importance to Portland in this classification is that known as "Natural cement" (also known as "Rosendale" and "Limerock cement") which is produced from the so-called cement rock above mentioned without reference to the proportion of lime or clay constituting its composition, hence, the process of making this class of cement is always dependent upon chance for results, and while it is suited for many purposes in construction work, its use is gradually falling off for important undertakings where reliability is an essential.

Third in the classification, gauged simply on the amount of the material produced, comes Slag or "Puzzolan" cement, which is produced by the mixture of blast furnace and/or foundry slag with limestone in proper proportions. As in this process are used hitherto

waste materials it is to be presumed that its future will show wide extension, though its past growth has been slow. None of this class came under inspection by the writer, hence, no attempt at description will be undertaken.

NATURAL CEMENT.

The American Society for Testing Materials stipulates that "this term shall be applied to the finely pulverized product resulting from the calcination of an argillaceous limestone at a temperature only sufficient to drive off the carbonic acid gas." Tests of neat cement briquettes to show initial-set in not less than ten minutes; hard-set in not more than three hours; to show a tensile strength of 50-100 pounds at end of twenty-four hours and of 200-300 at end of twenty-eight days. (It is to be noted that no specifications as to proportions of lime and clay or other material are stipulated.—G.)

Natural cement is secured from cement rock or hydraulic limestone, which is a combination of lime and clay, in varying proportions; it is found in natural deposits of large area in Ulster County, N. Y., in the Lehigh Valley in Pennsylvania and New Jersey, in southeastern Indiana, and elsewhere in smaller quantity. The preparation of cement from this rock is one of the most simple nature, it being only necessary to burn the raw stone in open top kilns, much like the lime kiln, grind the product to the proper degree of fineness and place it on the market.

The kilns are usually constructed of iron, lined with fire-brick, tapering toward the bottom where are placed grate-bars, below which are pits into which the calcined rock is dumped; process of operation is to make alternate layers of fuel and rock, ignite the fuel and draw off the calcined rock from the bottom about every seventy-two hours, the operation being continuous, more fuel and rock being added from top of kiln as the calcined material is removed from below. These kilns are usually ranged in parallel groups, with track for removal of burned material between, and are generally without covering or enclosure.

The burned rock passes from the kilns directly to the mills, first through a crushing mill or coarse grinder, then to a screen, the finest dust passing to barrels as cement, the tailings going back to the coarse mill for regrinding, while the bulk of the crushed rock passes through this screen to the finishing mill which is usually a buhr mill, whence it is again screened and barrelled or bagged as finished cement. The mill buildings are usually of light frame construction, detached from the kilns, and are seldom provided with other than wooden elevator legs and storage bins, this condition presenting an aggravated hazard, as the ground rock is frequently hot enough to set fire to the woodwork of the elevators and bins, even when iron lined. Aside from this special feature, the inherent hazards of the class are mild, being principally from friction at bearings from gritty nature of the product, and at screw conveyors if encased in wood, when the movement of the material is retarded by "choking" of the screw, these being in addition to the ordinary hazards to be looked for in manufacturing plants of all kinds.

The general impression of the class, so far as inspections have gone, is not entirely satisfactory, owing to the rather flimsy and unfinished nature of construction, general carelessness evidenced in operation and management and the cheap class of help. The machinery used is simple and not of expensive character, hence, the values at a plant are not usually large; in southern Indiana such plants are found to range from three to over thirty kilns each, with an average possible output of about 100 barrels per day per kiln, many of them being operated but part time and under individual ownership, though most of the plants in that region are said to be in a "trust," or working under an agreement whereby the larger plants take care of the smaller ones while idle by apportionment of their respective quotas of operative capacity.

PORTLAND CEMENT.

Portland cement differs from natural cement in that the ingredients entering into its composition (principally lime and clay with alumina and silica) are infrequently found in such natural proportions as to insure the production of a cement of uniform quality, it being an axiom in general acceptance that "to accurately proportion the raw materials and to perfect an intimate mixture of them are the prime factors in making good Portland cement. Other things being equal, the more exactly the proportions are maintained the greater the uniformity of the cement; the more homogeneous the mixture and the finer the state of division of its particles the greater the strength and hydraulic energy of the product." (Lewis.)

Hence, Portland cement is usually termed an artificial cement, and in the specifications for a standard of quality it is stipulated by The American Society for Testing Materials, that, "this term is applied to the finely pulverized product resulting from the calcination to incipient fusion of an intimate mixture of properly proportioned argillaceous and calcareous materials, and to which no addition greater than 3% has been made subsequent to calcination." Tests of neat cement briquettes to show initial-set in not less than thirty minutes and hard-set in not more than ten hours; to have a tensile strength of 150-200 pounds at the end of twenty-four hours, and of 550-650 pounds at the end of twenty-eight days. (Compare with definition of Natural cement.)

The two essential ingredients in the manufacture of Portland cement are lime (60-65%) and clay (40-25%); the former is found widely distributed throughout the country in form of limestone, and less general and in smaller volume in the shape of marl, while deposits of clay suitable for the purpose are usually found in the vicinity of limestone and marl deposits. In addition to these materials which are artificially mixed in proper proportions to produce Portland cement, there are, as noted under Natural cement, large deposits of cement rock in the Lehigh Valley region which is so proportioned in its natural contents of lime and clay as to be fit for the production of Portland cement without additions of either to balance, while in the same quarry portions of the deposit may need such additions to secure

proper results, in which case limestone and clay of proper composition are to be found in the vicinity.

There are two methods of producing Portland cement in general use in this country, known respectively as the "dry" and the "wet" process, the former class including practically all of the plants using limestone and clay, or natural cement rock as the raw material, while in the wet process are included those plants in which marl and clay form the raw stock. (It is interesting to note that only about 8.5% of the total output of Portland cement made in the United States in 1906 was produced from marl by the wet process, the plants of this character being principally in Ohio, Indiana and Michigan and are usually to be found located at or near the shores of shallow lakes of the glacial origin.)

THE DRY PROCESS.

In the *dry process* the limestone or cement rock is blasted out at the quarry beds, elevated to a stone crusher where it is roughly broken, then passed to a direct fire-heated dryer, usually a rotary iron cylinder averaging 5x50 feet and set at a slight inclination to the horizon, the fire being at the delivery end and the products of combustion passing through the cylinder and over the broken rock; passing from the dryer the rock is further broken in iron mills and elevated or carried on belt conveyors to raw stock bins, or may go direct to bins from the dryer if sufficiently reduced in size; clay from the pit or cars is dried in cylinders as noted for the rock, ground in edge-runner or tube mills, conveyed to stock bins and mixed with the crushed rock; the combined clay and limestone is then transferred to the "raw mills," where it is usually ground in ball mills and finished in tube mills to the consistency of fine meal; the ground raw stock may then pass to screens for grading, or go direct to iron food hoppers placed at the upper ends of the rotary burning kilns. These kilns are constructed of steel, cylindrical in shape, ranging from five to eight feet in diameter and from 50 to 130 feet in length (one plant proposes putting in kilns 200 feet long), lined with fire brick and set at a slight inclination to the horizon from feed to delivery end, and are slowly rotated by individual motors or engines, and are heated by the combustion of finely comminuted bituminous coal fed at the delivery end of the kilns under an air blast; the heat generated ranging from 2,500 to 2,800 degrees F.

The finely ground raw stock passes slowly through the length of the rotating cylinder, subjected to a rapidly rising temperature as it approaches the delivery end of the device, from which it is delivered to the cooling device at a white heat in the shape of a pebbly "clinker." The method of cooling the clinker is not uniform in all of the plants inspected, but the general results are identical in that the clinker usually becomes thoroughly cool before it is passed to the storage bins or feed hoppers of the clinker mills. The methods in use for grinding and finishing the cooled clinker into commercial cement are almost as varied as are the ideas of the management of the plant, but as a rule the clinker passes from the feed hoppers to ball or Griffin mills for the first grinding, and then to the tube mills for finishing, from these it may go to screen or bolts for grading, and thence by conveyors to the

finished stock warehouses, where it is usually stored in open bins for sixty days or more before being packed in barrels or bags and shipped.

Coal used as fuel at kilns and at boilers is of bituminous character of the so-called "high steaming" class; bulk stock is usually stowed in open piles, but may be found under cover or even inside of the coal grinding house. Practically all of such coal is prone to spontaneous heating in piles, this tendency being aggravated when the ground coal is allowed to accumulate in heaps. In the preparation of coal for use at the kilns it is first passed through a crusher or rough-mill, then to direct fire-heated dryers, elevated to iron hoppers and fed to Griffin or other pulverizing mills, usually located in the same compartment as the drying cylinder. In the best practice the pulverized coal passes from the mills by air blast to and through a dust collector, and thence by iron conveyors to the feed hoppers at the delivery end of the kilns, where, as above explained it is consumed within the kiln under air blast; in other instances the pulverized coal is elevated to a screw conveyor direct from the mills and thence to the feed hoppers, as above; again, the pulverized material may be piled on the floor in the dry-house, or be stowed in bins inside of or attached thereto; both conditions being unsafe.

THE WET PROCESS.

The operation of a "*wet process*" plant differs from that of a "dry process" only up to the point where the mixed ingredients enter the rotary kilns, from which latter point the methods and hazards are identical.

In the wet process the raw stock consists of marl and clay (an exception as to class of raw stock may be noted here, as discovered at a plant where the marl deposit had become exhausted; here, limestone reduced to a fine powder was mixed with clay to form "slurry"), both being handled while in a moist condition. Marl is a natural deposit of carbonate of lime, ranging from 40 to 97% of carbonate; it is found in the marsh lands at the borders of lakes and under the water of same at practically all depths, and varies in thickness of deposit from a few inches to many feet. In operation the marl is secured from its place of deposit by the use of steam dredges, dumped into scows and towed to the works, or it may go from the dredge to dump-cars on tramways operated by steam, rope, motor or animal power; the marl may reach the works in a semi-solid state, if from the marsh land, but it usually is of a pasty consistency, say 60% water, and in this condition may be forced to the raw stock bins by air pressure from the dredge, or be lifted by pumps at the works, in which case it has been freed from stones and other extraneous matter by a separator on the dredge, this operation otherwise taking place inside of the mills; from the separator the wet marl goes to the wet-pan mill, edge runners and usually the clay is mixed with it and the combined material is ground in the presence of water; thence it passes to tube mills, sometimes in the older mills to buhr stones and is finely comminuted; it is then termed "slurry" and is passed to an agitator or mixer, then to slurry storage tanks (where agitation is continued by air pressure to prevent stratification), from which it is elevated to hopper feed tanks, over the

feed ends of the kilns, or it may be forced to that point by pump or by air pressure. The slurry enters the kiln in a moist condition, holding from 35 to 45% of water which is vaporized and driven off as steam as the slurry slowly progresses through the kiln to the delivery end of the device. The clinker produced in this process is usually coarser and more lumpy than that of the dry system, thus necessitating separation before grinding and an extra crushing of these lumpy portions. Aside from this, the process from now on is identical with that of the dry process above described. The clay or shale used in the wet process is crushed and dried as described in the dry process.

CONSIDERATION OF HAZARDS.

Raw Stock, *dry process.*—Cement rock, limestone and clay are each inert.

Raw Stock, *wet process.*—Marl and clay being always moist are also inert.

Finished Stock, *both processes.*—Having been subjected to extremely high temperature in the kilns possesses no combustible quality, but may retain sufficient latent heat from milling to set fire to wooden receptacles; hence, all elevators, conveyor boxes and storage bins should be of non-combustible material. It is also to be noted that owing to the presence of free lime in the finished product, all woodwork exposed to same loses its contained moisture and becomes as readily inflammable as punk, notwithstanding the fact of its being coated with the cement.

Fuel, *both processes.*—Class of coal being high-steaming bituminous it is liable to ignite spontaneously when in large piles as it comes to the plant, hence, it should be piled in the open and be frequently tested for heating; ground or pulverized coal being peculiarly susceptible to self-ignition should never be housed in large quantity inside of any structure; preferably, it should be prepared in only such quantity as will supply the needs of the kilns, to the hoppers of which it should be transferred from the mills by iron conveyors; the most satisfactory method being by air-blast through metal pipes from mills to a dust collector; and thence by metal-cased screw conveyor to feed hoppers at kilns; if stored inside of buildings the bins should be of metal and of small capacity. Practically all of the coal used at the wet process plants in Ohio, Indiana and Michigan is that from the Fairmont mines in West Virginia, possessing the "fiery" characteristics of coal from that district.

PROCESS HAZARDS.

Rock Crushing, *dry process.*—This constitutes a mild hazard as the cement rock or limestone is roughly broken up as it comes from the quarry by passing through jaw-breakers or crushers of the so-called "coffee mill" type. The surroundings are usually rough and not readily combustible.

Drying, *rock and/or clay.*—Both classes of stock are usually dried by being passed through slowly rotating iron cylinders which are heated by coal fuel, the flame and products of combustion passing

through the cylinders in contact with the material and escaping at the upper or feed end of same through iron or brick stacks; these dryers are usually unenclosed, but as flame from the combustion chamber frequently is permitted to escape at the junction of the dryer and the firebox, the device should be kept free from exposure to or contact with woodwork or other combustible material; where the drying device is enclosed in masonry, the walls should be free from cracks and iron backstays be used for its support and be freed from contact or exposure to woodwork or combustibles. The hot stone should be conveyed through iron transmissions to the cooling pit or bin, before going to the raw stock warehouses for storage.

Drying Coal Fuel, *both processes.*—Coal is usually crushed by power in a coffee-mill device, though this is sometimes accomplished in an iron mill usually of the Williams type; is elevated to an iron hopper over the dryer, which is usually an iron cylinder enclosed in brick work and set at an inclination to the horizon from feed to delivery end, and heated by direct fires under the rotating cylinder in furnaces within its brick enclosures. The precautions noted above in relation to the location and arrangement of the raw stock dryers should be called for in this class. The dried coal passes by iron elevators to feed hoppers over the Griffin or other pulverizing mills, thence is conveyed to kiln hoppers or storage bins by elevators and screw conveyors, or as above indicated, by air-blast through metal pipes to dust collector; thence to kiln fuel hoppers by screw conveyors encased in metal, this method of handling fuel promising the greatest measure of safety from fire, as there is less finely pulverized dust held in suspense in the atmosphere. Coal ground in Griffin, tube and other partially open mills gives off much fine dust to the atmosphere, while the ball mills are but little less objectionable in that respect. I am advised that while the "Williams" mill used as a crusher of raw coal has seldom caused trouble, several fires and explosions are ascribed to its use for pulverizing the dried coal, an item well worth keeping in mind on inspection.

The extreme hazard of combining the fire-drying and pulverization of coal under the same roof does not appear to have very strongly appealed to the average manager of cement works, and yet it is the most striking and menacing of the processes incident to the production of cement. All drying devices should be separated from the grinding department in the manipulation of coal fuel, and that this method is feasible is amply demonstrated by the practice at the Atlas Cement Co.'s works at Northampton, Penn., where drying of stone, clay and coal is carried out in the open, under ordinary shelter-roof sheds detached from other buildings.

Raw Stock Mills, *dry process.*—The broken raw stock, cement rock, or the mixture of limestone and clay is usually conveyed from the raw stock bins to the hoppers of the rough mills by belts, and is reduced to a coarse meal by passage through mills of various makes, from which the material may be graded on screens or in bolts, and then passed to the finishing mills, usually the tube mill pattern, the resulting output being very finely comminuted and the ingredients very intimately mixed. While some frictional heat is generated in

these mills in the reduction of the hard stone, it does not appear sufficient to cause ignition of combustibles in contact with it, but the fine dust from the limestone has the quality of absorbing the moisture from the woodwork upon which it settles, as noted above in relation to the finished cement. An exception must be noted in respect to plants, which, while continuing to operate by the wet process, have substituted limestone in place of marl and must reduce the stone to extreme fineness in pulverizing mills run at such high speed and pressure as to heat the meal to a degree which might cause fire in contact with wooden conveyors or receptacles. In such cases elevator legs, conveyor casings and hoppers should always be of iron.

The grinding and mixing of raw stock (marl and clay) in the wet process plants carries no hazard with it, the materials being mixed and ground while in a fluid state as explained above.

Burning Kilns, *both processes.*—While the intense heat (2,500-2,800 degrees F.) generated in these devices during operation as well as that which is emitted by the hot clinker as it falls from the kiln, appears to present a very marked hazard, it is in fact quite a negligible item of the process, as the very intensity of the heat compels fire-proof construction in its vicinity, as well as liberal space on all sides and a high roof to insure ventilation; the radiated heat, however, will rapidly dry out any woodwork in the structure and render it more readily ignitable in case of fire from any cause. At one plant the wooden hand-rails to the stairways and galleries which are located well above the kilns, were found to be uncomfortably hot to the hand and it can well be conceived that a fire once started would spread with great rapidity under such conditions; hence, the presence of much woodwork such as platforms, galleries or roof boards in the kiln house deserves careful consideration by the inspector. Care should be taken during the process of cooling the clinker that it be kept free from combustible material, and that it be not stored in bins subject to ignition until it has become cooled; such bins should always be non-combustible.

The most dangerous hazard of the kiln room is found in the storage, handling and method of burning the pulverized bituminous coal fuel, as there appears to be the possibility of a dust explosion due to the delivery of an excess of the fuel from the feed hoppers, which may happen in the most approved system, when through accident or from carelessness the air-blast is shut off before the delivery of fuel through the feeding device has been stopped; hence, any system which does not provide for the shut off of the feed before the air-blast ceases, is dangerously defective, fire wise.

In the best practice, usual to modern plants, the coal is delivered to the tops of iron feed hoppers by screw conveyors enclosed in metal casing, and is automatically fed from the botton of the hopper by a screw conveyor enclosed in an iron pipe, the end of which is connected to the air-blast pipe leading to the kiln head; the pulverized coal as it falls from the feeder into the air duct, is met by a blast of hot air which forces it into the kiln in such state of distribution as to insure rapid and complete combustion with intense heat. Separate hoppers are provided for each kiln, the flow of fuel and the blast of

air being controlled at each hopper by geared connection to the fuel feeding screw, and by a cut-off valve in a branch pipe from the general air-blast. Under another and approved system, the power for operating the feeding mechanism and the air-blast is secured from induction motors attached and individual to each hopper and air-blast.

Where, as in the older practice, fuel is fed from the bottom of the hopper without the aid of a screw conveyor and is met by a fan-blast as it falls, or where the fuel is forced to the kilns by being carried through the vanes of the fan with the air, the hazard may be considered as excessive and the conditions dangerous.

Screw Conveyors where in use for the movement of hard and dry material, whether coal, raw stock, clinker or finished cement, should invariably be enclosed in metal casing, as they frequently become choked and the frictional heat generated by the action of the screw on the material banked up in its convolutions may become intense enough to ignite the encasement if it be of wood.

Electric Motors.—Many of the plants now maintain their own electrical generating plants, and operate machinery and devices by individual motors, generally and preferably of the induction type, which are sparkless. It is evident that none but induction motors should be used where coal is ground or otherwise handled by power, as the sparking from the commutators of the direct current motors might easily ignite the material when in a finely comminuted condition.

Causes of Fires.—As a result of diligent inquiry and investigation as to the known causes of fires in plants of this class, the conclusion has been reached that where they have originated in the manufacturing sections and have not been the result of ordinary conditions incident to any class of risk they have generally occurred in the coal preparation department, either from friction in the grinding mills, due to the presence of foreign matter in the coal, and usually resulting in an explosion as well as fire; or by ignition of coal dust in same locality from furnace fires at the dryers, and/or from spontaneous ignition of coal in piles, both ground and unground, inside and outside buildings.

Fires in finished stock warehouses mark a good second to those of the coal preparation localities, and when not due to normal or ordinary causes, it is my opinion that they arise from the clogging or choking of screw conveyors encased in wood, and as such casing is deprived of its contained moisture by the action of free lime in the cement which envelops it, it is in prime condition for ready ignition at a comparatively low temperature. A large majority of the finished stock warehouses inspected developed the fact that roof boards were laid on wooden trusses supported by wooden beams and posts, while the open top cement bins were also enclosed in wood, with wood encased screw conveyors overhead or under floor level, or both.

In addition to the above notes on the hazards of processes particular attention is called to the following features which render a risk thoroughly objectionable from a fire standpoint:

All classes of cement works where the drying and preparation of coal fuel is carried on inside the main plant, or in adjoining structures not safely cut off.

All classes of cement works where the kiln house is wood, or in which wood largely predominates in the structure.

Cement works where wooden elevator legs, conveyor casings or storage bins are used in handling hot material.

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Kiln houses where pulverized coal fuel hoppers are not provided with screw conveyor feed control, or where fuel is directly fed to the kilns through the blowing device.

Fuel preparation plants when both drying and grinding coal is carried on under the same roof; when ground coal is stored in bulk in the mill room; when the machinery is operated by direct current electric motors inside the structure.

In addition to the above the following should be carefully scrutinized:

All plants which have been converted from old-style intermittent furnace to rotary kiln process, or from marl to limestone raw stock, wet or dry process, as in each case much "junk" is to be found and the construction is usually faulty.

All kiln or other buildings where heat is generated, where roofs with wooden sheathing or supports are low, and where much woodwork appears, as in galleries, platforms or machine encasements.

Finished stock warehouses where bins are of wood and screw conveyors are wood encased; in such cases the conditions aggravate the hazard seriously.

In addition to the above specific cautions, attention is called to other and inherent hazards, as noted in description of processes, all of which are worthy of careful consideration on inspection; there are also to be found other hazards not incident to the processes such as carpenter shops, machine shops, electric light plants, and perhaps a cooper shop, proper inspection of which should not be overlooked.

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WET VERSUS DRY PROCESS.

In view of the fact that Portland cement when made from cement rock or from limestone and clay of suitable quality is credited by experts as being much superior in every essential respect to that produced from marl and clay, and therefore controls the market, it would seem that in competition the marl plants will have to be content with lower prices and curtailed profits to hold their own against the dry process plants, and when to this trade handicap we add the fact of the practically limited area of workable marl deposits as compared with the widespread and unlimited supply of limestone and clay of suitable composition for the production of Portland cement, the conditions appear to warrant especial attention being given to the business conditions surrounding marl plants, and in support of this conclusion the following remarks are submitted:

Deposits of marl, like those of petroleum and natural gas, are found only in restricted territory, and in each case, when the deposit has once been exhausted, there is no natural replacement of the material extracted. The marl deposits cannot be profitably worked if lying under more than fifteen feet of water, or more than four feet of

muck or peat bog; when the marl deposit is over twenty feet in thickness the lower portions are usually so contaminated with other matter as to render them useless as the basis for cement; hence, in working a marl bed it is apparent that the limit of profitable operation is confined within restricted areas, few if any of which give promise of extended availability.

It requires one half of a cubic yard of marl as it comes from the deposit to produce one barrel of cement, hence, given a mill with capacity for say 500 barrels a day, it would need a surface area of one acre over a deposit of marl eighteen feet thick for three months operation, or four acres per year of operation, and as a plant of 500 barrels per day capacity would involve an initial cost of at least $350,000, for plant and equipment alone, it is evident that a long term of years of successful operation would have to be assured to warrant so large an investment of capital, even if such an unusual deposit of marl as eighteen feet should prove all workable during a period of thirty years, and both of these propositions are doubtful, as the average workable deposit of marl seldom exceeds a thickness of ten or twelve feet where the depth of water is less than fifteen feet, or that of the muck less than four feet, which, as stated above, are the extremes of the obstacles which may profitably be overcome in marl recovery.

Inspections developed the fact that several marl plants had exhausted the immediate deposit, necessitating "going far afield" for a new supply at the expense of building a railroad for transportation, or, as in one instance, the substitution of limestone for marl, and working it wet, rather than incur the expense incident to discarding the old equipment and replacing it by new for the dry process system. Under these adverse conditions the day of the passing of the wet process with marl and clay as raw stock seems to be plainly marked, and its gradual replacement by the dry process system using limestone and clay is as plainly assured.

In support of the above conclusions, the following extract from the advance publication of the report of The United States Geological Survey, covering "The Cement Industry of the United States in 1906" (E. C. Eckel) will prove of interest:

"From what is known of the present condition of marl and slag plants, and of plans for future changes and new construction, it is probably safe to say that within four years more Portland cement will be made from slag than from marl. It must be recognized that marl plants operate under serious natural disadvantages, that these disadvantages are masked by general high prices during such prosperous seasons as we have recently experienced, but that they become painfully apparent during years of general depression. When cement sells at 85 cents or less per barrel at mills in the Middle West, as it may very well do in 1908 or 1909, it will be an even more serious matter to have water in the raw mixture than to have it in the stock." (E. C. Eckel).

IN CONCLUSION.

To insure success commercially a cement plant should possess the following points of advantage in its favor:

An extensive, readily handled deposit of raw material of purest character.

An outfit of the strongest and best designed machinery.

An output of large capacity.

Cheap power, either by water or by coal mined at or near site of plant.

Location such as to insure ample means of transportation for product.

Skilled operation and close adherence to accepted standard in composition of the finished product.

The nearer any plant combines the above conditions in its makeup, the more certainly will its profits be assured.

F. M. GRISWOLD, *General Inspector,*
The Home Insurance Company.

New York, October, 1907.

Gypsum Plaster Mills.

Cement plaster is variously known as "Stucco," wall-plaster, plaster of Paris, the latter term being the proper one, as it represents the material base of the others, it being the product of crushed and calcined or "cooked" gypsum.

Specifically and properly, "Stucco" is a mixture of plaster of Paris and glue, while wall-plaster is a mixture of plaster of Paris with sand, wood or animal fibre, and/or other material.

Gypsum, from which plaster of Paris is made, is one of the softest of minerals; it is chemically classed as a calcium sulphate in combination with water. It is found in workable deposits throughout the United States, both as a crystalline rock and as a granular mixture of earth and gypsum, the latter being known as "secondary gypsum," also "gypsite" and as earthy gypsum. Both rock and secondary gypsum may occur in the same locality, but the earthy gypsum is generally confined to districts west of the Mississippi River, while the rock variety is widely distributed throughout the country, the most remarkable deposits of both rock and secondary gypsum being found in the almost unbroken formation extending in a southwesterly direction from Blue Ridge, Kansas, to Quanah, Texas.

Gypsum is crystalline in structure, having a specific gravity of 2.32 in its raw state and of 1.81 when calcined. It is secured as rock from workings in open quarries, by drifting or tunneling into the deposits, or by shaft mining, and is usually thrown from placement by the use of dynamite.

Secondary gypsum or "gypsite" is found and worked principally in the states of Kansas, Texas and Wyoming, as well as in Oklahoma and Indian Territories. It is an earth of granular formation, usually deposited in swampy ground. It is soft and easily recovered by digging by hand or machine, and when mined, needs no preparation to fit it for calcination, hence, where it abounds, plaster of Paris may be more economically produced from it than from the rock gypsum, but as an offset to this economical feature, it is to be borne in mind that deposits of "gypsite," like those of marl (referred to in my report on Portland cement) are variable in volume and not always of sufficient area and depth to warrant exploitation, hence, care should be taken to secure reliable information as to the extent of the deposit before acceptance of lines on plants using "gypsite" as sole source of gypsum supply in plaster manufacture.

The uses to which gypsum may be put are various, the raw rock when simply pulverized is known as "land plaster," and is used as a fertilizer; also, under the term "terra alba," as an adulterant for wheat flour, and in mixtures or compounds, as a base for insecticides, and as a retardent in Portland cement, but the principal use of the raw gypsum is for the manufacture of chalk crayons and like products.

Calcined gypsum is known as plaster of Paris, the finer grades being known as dental plaster when it has been carefully reground and freed from gritty particles, and a similar grade is much used for bedding plate glass on the polishing tables of glass works.

Wall plasters under various trade names are made from plaster of Paris mixed with a retarder, or by a mixture of plaster of Paris, a retarder and sand; and also by the admixture of animal or vegetable fibre with the plaster of Paris.

The gypsum industry is well established and is rapidly growing in many of the states and its production appears to be practically under the control of a few organizations, the principal of which are the United States Gypsum Co., the American Cement Plaster Co., and the Acme Cement Plaster Co. In 1903 the United States Gypsum Co. controlled eighteen plaster mills, thirteen mixing mills and three chemical plants, this corporation being capitalized at $7,500,000. In addition to these larger corporations there are many smaller ones and numerous individual plants of relatively small capacity.

PROCESSES.

The essential conditions necessary to the production of plaster of Paris or stucco are to reduce gypsum to the finest possible powder or "flour" before passing it to the cookers or calcining kettles, and then to apply only such degree of heat as will serve to carry off such proportion of its contained moistures as will prevent the voluntary "setting" or hardening of the finished material when exposed to the atmosphere. Hence, where the rock gypsum is used it is put through many processes of breaking and grinding to reduce it to proper degree of fineness for cooking, while in the use of "gypsite" or earthy gypsum, its natural condition of granulation permits it to go at once to the calcining kettles without preliminary treatment, thus insuring larger economy in handling than is the case with the rock.

The rock gypsum after being thrown down by blasting with dynamite at the mine or quarry is conveyed by tramway, usually, or an inclined trestle, to the mill, where, in most instances, the broken rock is passed through a brick encased iron cylinder dryer, with direct fire heat, or may first be passed through a "jaw-breaker" and then to the dryer, or to the breaker without being dried. The rock, as it leaves the breaker is reduced to pieces the size of a man's hand and then dropped to the hopper of a second crusher or "cracker" of the coffee-mill type, from which it issues as a gravel, in which state it is elevated to feed bins over the grinding mills.

The broken rock flows by gravity from the bins to ordinary buhr mills (many of them being second-hand devices from old-style flour mills), where it is reduced to a flour-like fineness, and is then elevated to a bin over a second set of mills, usually of the vertical type, with emery-faced mill stone, in which it is reduced to an impalpable powder; these mills running at high speed, heat the material to a degree warranting the use of metal elevators or conveyors and storage bins.

From these finishing mills, the flour is usually transferred by conveyors and elevators to the bolts or screens, from which the "tailings" return to the mills for re-grinding, and the screened flour falls by gravity to storage bins over the cookers or calcining kettles. In some instances however, the flour is carried from the mills as above

described, to the bins over the cookers and from the latter passes to the bolts or screens after cooling.

The cookers or calcining kettles are iron or steel cylinders three-eighths of one inch in thickness, eight to ten feet in diameter, and the same in height; they are set on brick foundations over a furnace and enclosed in brickwork from twelve to eighteen inches in thickness, the inner wall being fire-brick, an annular space being left between the brickwork and the shell of the cooker for the circulation of heat from the furnace beneath. The flour from the storage bins above mentioned is fed by gravity to the cookers (which, of the size mentioned, have capacity for calcining about three and one-half tons of ground gypsum per hour), where it is subjected to a heat of 230 degrees F. at which temperature it boils vigorously, giving off water vapor, which rises through the venting stack to the outer air.

The flour is stirred or agitated during the period of cooking by a rotating arm having pendant lugs or arms which keep the flour in constant motion. When the temperature of the flour reaches 270 degrees F. the mass settles down almost solid and ceases to evolve steam, and when the temperature rises to 280 to 290 degrees F., violent ebullition sets in, the boiling flour often being thrown over the top of the kettle; when the temperature reaches 350-370 degrees F. the mass is ready for withdrawal through gates at the bottom of the kettle, into a cooling pit or bin, constructed of fire-brick or cement, where it is supposed to remain until sufficiently cooled for transfer by conveyor to finished stock bins as plaster of Paris.

From these bins the material is conveyed to various other bins, if as plaster of Paris, to the warehouses where it is bagged or barrelled; if as wall plaster or retarded plaster, to the mixing device, thence bagged or barrelled or stored. It may be noted here that if the gypsum is to be converted into land plaster, it goes from the mills to warehouse without being cooked or calcined.

Retardents are used to delay the "setting" of the plaster in the proportion of about six pounds to the ton, being added at the mixer, the material presenting no hazard.

Wall plaster is prepared by adding animal (hair) or vegetable (wood) fibre to the plaster of Paris at the mixing machine, the operation creating no notable hazard, but the storage of the fibre inside of the mill structure should be restricted to a day's supply at most.

Hard wall plaster is produced by adding to the plaster of Paris various materials such as sand, marl, fire-clay, etc., in addition to a retarder, the mixing being without notable hazard.

Alabastine; anti-kalsomine, Lieno; cold-water paint and like wall finishing or surfacing material is produced from the finer grades of gypsum, which after having passed through the processes above described, is reground and repeatedly bolted or screened to reduce it to an extremely fine powder; it is then mixed with powdered dry metallic colors and glue, which has been ground to powder in a dry state, the mixture being finished by cooking in steam heated open top revolving metal pans, from which it is conveyed to cooling bins and from thence to the packing room, where it is usually put up in five-pound paper packages and shipped in barrels or crates of wood.

HAZARDS.

Rock Dryers present the hazard usual to heat producing devices, and should be located at a safe distance from woodwork or other combustible; the enclosing brick wall should be free from cracks and be supported by iron back stays; smoke stacks should have proper clearance at roof passage. As a preference, dryers should be located apart from the main buildings.

Rock Crushers and crackers present no points of hazard requiring particular note.

Buhr Mills present only a mild hazard in operation, but the stones may be set so close or be speeded so high as to heat the product to an appreciable degree, hence all conveyors, elevators, casings and storage bins for the flour should be of metal.

Emery Mills; the grinding faces of this class of mill are made of a very hard emery rock and operate in a vertical position at high speed, which tends to so materially heat the product as to emphasize the necessity for iron casings to conveyors and elevators, and fire-proof storage bins for the flour produced.

Sand Dryers are usually heated by direct coal fires, and are not infrequently of improvised or make-shift character, but in any case proper protection against exposed woodwork or other combustibles should be insisted upon. From the fact that sand from the dryer retains its heat for a long time after removal from the device, it should always be stowed in metal or other non-combustible receptacles, and in transit to such deposit should pass only through iron cased conveyors or elevators.

Sand Grinding Mills present hazards similar to those noted regarding emery mills, and the same precautions there noted apply here.

Bolts and Screens are slow motioned devices and present practically no hazard in operation, though fires have been known to occur in them when incased in wood and the flour from the cooker comes to them before having been properly cooled.

Cooker or calcining kettles; this device is a heat producer of note, hence the nature of its construction and environment should be such as to avoid possible over-heating or ignition of exposed woodwork, precautions such as noted relative to rock dryers being in order. A superior method of construction for this class of device was seen at the so-called "Marsh" plant of the United States Gypsum Company, near Port Clinton, Ohio, where the ordinary eighteen-inch brick wall surrounding the kettle was reinforced by a boiler iron shell, set at a distance of six or eight inches from the brickwork and the intervening annular space filled with wet plaster of Paris; all woodwork near these kettles being cut away eight to ten inches, with their exposed surfaces covered with plaster board, each kettle having a brick, cement-lined cooling pit attached, an exceptionally good and satisfactory arrangement.

Cooling Pit to cooker should not only be of fire-proof construction, but should also expose no woodwork, while the casing of conveyors and elevators handling the flour should be of iron leading to a fire-proof storage bin, as many fires have originated from carelessly transferring

hot flour through wooden devices to wooden storage bins, this being the principal cause of fires in the class.

Plaster Mixers present only a mild hazard in operation, negligible.

Fibre Machines operating on wood are similar in hazard to excelsior machines, the material being produced by means of toothed saws set spirally on a horizontal cylinder operated by power, a log of wood first denuded of its bark, being held against the saws until it is reduced to shreds. These machines should not be located inside of the main plant, and the shredded material kept inside the plant should be limited to one day's supply, as it rapidly dries out and is inflammable.

Fibre Machines working on animal hair are devices similar to the "lumper" used in mixed mills for opening lumpy stock; they are however, smaller, and are usually operated by hand, though sometimes by power; they create much combustible dust in operation, and the opened, broken fibre is usually delivered on the floor, or into an open wooden box at the device. Should be located in separate enclosure, or preferably, outside of main structures, and the material be limited to one day's supply at the mixer.

Retarders when used as a commercial product, made outside of the premises, present a negligible hazard. As most of the retarders are patented compounds of secret ingredients, it will seldom be found that they are manufactured at the plaster mills, hence discussion of the process will be omitted.

Alabastine, anti-kalsomine, etc., is but a refinement of plaster of Paris, as noted above, leaving out the hazard of the cooking kettles, the substitution of which by the steam pan cookers presenting a mild hazard.

CONCLUSION.

Taken as a class, the average plaster mill is not attractive in appearance, nor entirely satisfactory as to construction, in both of which respects there is much room for profitable improvement. The business is rapidly growing in importance and it may be expected that the number of plants will increase in proportion to the demand for the material, thus providing a sufficiently large aggregation of risks to promise an average of experience in the class, the general hazard of which places such plants on same level as natural (Rosendale) cement works and modern lime kiln works.

Yours very truly,

(Signed) F. M. GRISWOLD, *General Inspector,*
The Home Insurance Company.

Report on Fire at Superior, Wisconsin.

KEY TO MAP.

Figures shaded represent buildings destroyed by fire.

° Represents hydrants.

Fig. 1. Great Northern Elevator X. Metal-clad, frame and crib construction with metal roof. Connected to Elevator A by a frame conveyor house. Height, 125 feet. Capacity, 1,500,000 bushels. Protection, hydrants as shown on map. Three standpipes. Hibbard sprinklers installed in 1897 by Mallers-Allen & Fraser and controlled by three Manufacturers' dry pipe valves. System sub-standard. Water supplies, one 1,500 gallon Underwriter and one 600 gallon Commercial pump, three 4,500 gallon pressure tanks.

Fig. 2. Boarding House and Office of Paymaster of Great Northern Railway Warehouse. Brick, with gravel roof.

Fig. 3. Great Northern Railway Warehouse. Two-story, metal-clad frame and ordinary joist construction with gravel roof. Occupancy, package freight. Protection, water casks and pails.

Fig. 4. Great Northern Elevator A. Metal-clad frame and crib construction with metal roof. Height, 153 feet. Capacity, 2,000,000 bushels. Contained 585,000 bushels at time of fire. Protection, hydrants as shown on map. Eight 2½-inch standpipes in main floor, four in upper floor. Hibbard sprinklers installed by Mallers-Allen & Fraser in 1897; 812 sprinklers in main floor controlled by four Manufacturers' dry pipe valves. System sub-standard. Water supplies same as Elevator X.

Fig. 5. Great Northern Elevator Power House. One-story brick with metal roof on one-inch boards on metal trusses. Occupancy, boilers, dynamos and fire pumps. Fired by flames and heat from Elevator A.

Fig. 6. Great Northern Elevator Carpenter Shop. One-story, metal-clad frame construction.

Fig. 7. Great Northern Elevator Superintendent's Office. One story light frame construction.

Fig. 8. Great Northern Elevator S. Steel construction throughout except floors, which are three-inch wood except concrete in basement and steel plate in top floor. Height, 236 feet. Capacity, 3,100,000 bushels. Protection, hydrants as shown on map. Eight 2½-inch hose connections in main floor, five 1½-inch connections in each of other floors. Niagara Hibbard sprinklers installed by Niagara Fire Extinguisher Co. in 1901 and controlled by five Niagara dry pipe valves. Sprinklers in basement and main floor only. Water supplies, same as Elevator X.

Fig. 9. Globe Elevator No. 1. Metal-clad frame and crib construction with metal roof. Height, 145 feet. Capacity, 800,000 bushels. Protection, hydrants as shown on map. Three six-inch standpipes. Grinnell sprinklers installed in 1888 by Providence Steam & Gas Pipe Co. and controlled by two Grinnell dry pipe valves. System obsolete. Water supplies, three 600 gallon Smith-Vaile duplex, commercial pattern pumps and three 4,500 gallon pressure tanks.

Fig. 10. Globe Elevator Pump House. One-story brick with gravel roof.

Fig. 11. Globe Elevator No. 2. Metal-clad frame and crib construction with metal roof. A storehouse. Height, 80 feet. Capacity, 1,835,000 bushels. Protection, hydrants as shown on map. Four standpipes. Grinnell sprinklers installed in 1888 by Providence Steam and Gas Pipe Co. and controlled by one Grinnell dry pipe valve. System obsolete. Water supplies same as No. 1.

Fig. 12. Globe Elevator No. 3. Metal-clad frame and crib construction with metal roof. Height, 120 feet. Capacity, 1,835,000 bushels. Protection, hydrants as shown on map. Four standpipes. Grinnell sprinklers installed in 1888 by the Providence Steam and Gas Pipe Co. and controlled by one Grinnell dry pipe valve. System obsolete. Water supplies same as Elevator No. 1.

Fig. 12A. Small one-story frame dwellings fired by flying brands from Elevator A. Fires extinguished by fire department.

Fig. 12B. Lehigh Valley Coal Dock Co. Steel hard coal storage buildings and frame loading sheds.

Fig. 13. Old tug and dredges destroyed by firebrands from Elevator A.

Fig. 14. Great Lakes Dock & Dredge Co. One and two-story brick building with metal roof, in poor repair. Other buildings light frame construction. Brick building, used as machine shop; frame buildings used as carpenter shop, ice house, dwelling and other purposes.

Figs. 15 and 16. Superior Manufacturing Company. One and two-story frame buildings, occupied for wholesale building materials, cooper shop, stave mill, lime kiln.

Fig. 17. Duluth-Superior Storage Co. Storehouse. One and two-story metal-clad frame with metal roof. Occupancy, storage of furniture.

Fig. 18. Duluth-Superior Storage Co. Formerly Grand Republic Flour Mill and Warehouse. Mill, seven stories; Warehouse, three stories. Brick and heavy joisted construction with gravel roof. Mill occupied by Webster Mfg. Co. for finishing and storage of furniture. Warehouse occupied by D.-S. S. Co. for storage of grain in sacks. Protection, one standpipe in mill section. Water supply, a 750 gallon duplex pump. Public hydrants as shown on map.

Fig. 19. Grand Republic Elevator. Metal-clad, frame and crib construction with metal roof. Height, 72 feet. Capacity, 2,000,000 bushels. Contained 127,000 bushels at time of fire. Protection, one standpipe. Water supply same as mill. Public hydrants as shown on map.

Fig. 20. Minkota Flour Mill. Six-stories, metal-clad frame construction with metal roof. Machinery removed, used for storage of salt in barrels. Protection, public hydrants as shown on map. Mill was equipped with Grinnell sprinklers installed in 1894 by the General Fire Extinguisher Co. and controlled by one Grinnell dry pipe valve. Water supplies, one 600 gallon duplex commercial pump and one 4,500 gallon pressure tank. Sprinklers were out of service and part of piping removed.

Fig. 21. Minkota Elevator. Metal-clad frame and crib construction with metal roof. Height, 100 feet. Capacity, 1,500,000 bushels. Empty at time of fire. Protection, public hydrants as shown on map. Grinnell sprinklers installed in 1894 by the General Fire Extinguisher Company and controlled by one Grinnell dry pipe valve. Water supply, same as mill. Sprinklers out of service.

Fig. 22. Ruins of Commander Flour Mill, destroyed by fire April 18, 1906.

Fig. 23. Twohy-Eimon Mercantile Co. Wholesale grocers. Bemis Bag

Co., Bag Factory. Both buildings four-story brick with gravel roof.

Fig. 24. Freeman Flour Mill. Six stories, brick and heavy joisted construction with gravel roof. Capacity, 1,500 barrels flour per day. Not in operation at time of fire but machinery in place ready to operate. Protection, one four-inch standpipe. Grinnell sprinklers installed in 1892 by the General Fire Extinguisher Co. and controlled by one Grinnell dry pipe valve. Water supplies, one 750 gallon Underwriter Pump and two 4,500 gallon pressure tanks.

Fig. 25. Freeman Warehouse. Two and three-story, metal-clad frame with composition roof. Practically vacant. Protection, Grinnell sprinklers installed in 1892 by General Fire Extinguisher Co. and controlled by two Grinnell dry pipe valves. Water supply same as mill.

Fig. 26. Freeman Elevator. Metal-clad, frame and crib construction with metal roof. Height, 100 feet. Capacity, 2,000,000 bushels. Empty at time of fire. Protection, one three-inch standpipe; Grinnell sprinklers installed in 1892 by General Fire Extinguisher Co. and controlled by one Grinnell dry pipe valve. Water supplies same as mill.

Fig. 27. Dredges slightly damaged.

Fig. 27A. St. Paul and Western Coal Docks Company's Scale House. One-story frame with shingle roof. Slightly damaged by fire from flying brands from Elevator A 3,900 feet distant. Fire extinguished by fire department.

Fig. 28. Remaining half of old boat "LaFayette" damaged by flying brands.

Fig. 28A. Old boat "Swain" destroyed by fire from flying brands.

Fig. 29. Small frame dwellings and barn, destroyed by fire from flying brands.

Fig. 30. Kimball School, slightly damaged by flying brands.

Fig. 31. Small frame dwelling, slightly damaged by flying brands.

Fig. 32. Superior Ship Building Company's Plant. The building badly damaged by flying brands from buildings on Hughitt's Slip, 2,000 feet away. Fire extinguished by fire department.

Fig. 33. Northern Coal Dock Co. Flying brands lit here, but were extinguished by company's men before doing any damage.

On November 8, 1907, a fire occurred at Superior, Wis., destroying four elevators, three mills, one power house, one machine shop, one boat, one tug, four dredges, three dwellings and one barn, besides damaging numerous dwellings, mills, coal docks, lumber yards and dredges.

Superior is located on low, level land and a considerable portion of the land in the extreme northwest end of the city, on which were located the elevators and mills that were destroyed, is "made land," penetrated by numerous slips, several of the buildings being erected on pile foundations, and conditions were such as to favor the rapid and widely extended spread of the fire.

At the extreme northwest corner of the city is located the Great Northern Railway Warehouse and the Great Northern Elevators, S, A and X and Power House, shown on map at Figures 1 to 8. Six hundred and twenty-five feet east of these, across a marsh and slip, are the Peavey Elevators, known as Globe Elevators Nos. 1, 2 and 3 and Power House, shown at Figures 9 to 12. About 800 feet east of these are the buildings

of the Lehigh Valley Coal Dock Co., shown at Figure 12B. Still further east and across Tower Slip at a distance of 2,200 feet from Elevator A was located the Great Lakes Dock and Dredge Company's plant, shown at Figure 14, part of which was formerly a Smelter Works. East and south of these the Duluth-Superior Storage Company's buildings, formerly the Grand Republic Mill and Warehouse, also the Grand Republic Elevator, the Minkota Mill and Elevator, the Superior Manufacturing Company, Strothman Iron Works, Buffalo Oil Company, Twohy-Eimon Mercantile

Showing Great Northern Elevator A and Dock Before the Fire, as Viewed from the Northwest.

* indicates the point where the fire was first discovered. Close observation shows the basement ventilator holes at dock line through which the fire probably entered the basement, one under each window. View of doors is obstructed by the loading spouts. A small portion of Globe Elevator No. 2 is seen beyond the base of the smokestack.

Co. and Bemis Bag Company, shown at Figures 17 to 23. One hundred and eighty feet east of the Grand Republic Elevator and across Hughitt Slip, were the Freeman Mill, Warehouse and Elevator, shown at Figures 24 to 26.

Across Howard's Pocket on Connor's Point, are coal docks, school, church and rows of small frame dwellings, some of which are shown at Figures 29 to 31. Two thousand feet southeast from Freeman Elevator, is the Superior Ship Building Company plant, shown at Figure 32.

The fire is believed to have started under the dock on the west side of Elevator A, about 90 feet from the south end of the elevator. Several theories as to cause are advanced, two of which seem plausible. A steamer was loading coal at Great Northern A during day and hot coals or ashes from galley were thrown from boat and lodged on floating debris, which may have been carried against or under dock.

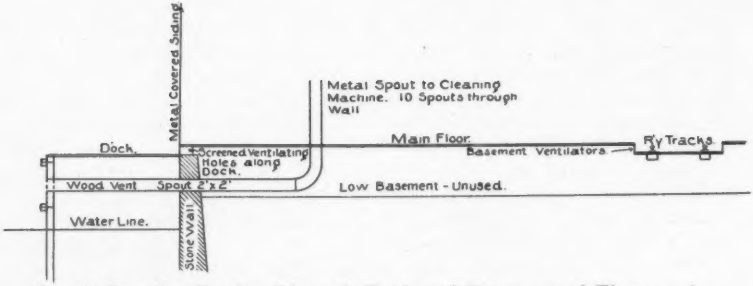
Another possible solution is that fire may have been caused by gasolene escaping from launch which was berthed for the winter under dock about 150 feet south of elevator. Owner of boat claims the storage tank was emptied, but as an explosion was the first medium to attract attention to the fire and as the fire had not gained sufficient headway to cause dust explosion, the gasolene launch may have been the primary cause of the fire. It was discovered about 7.04 p. m., by an employee of the Great Northern Warehouse, who was sitting in the boarding-house shown on map at Figure 2, and who heard an explosion and went out on the dock to ascertain the cause. As he approached Elevator A, he saw sparks coming up through the dock alongside of the elevator, about 90 feet from the south end. The employee ran to the paymaster's office and had the paymaster telephone the Superior Fire Department, also the fire tug at Duluth, the elevator superintendent, and others. About this time fire box No. 413, located near the boarding-house, was pulled. The Superior Fire Department records show that the telephone call was received at 7.09 p. m., the box call at 7.12 and a general alarm at 7.30 p. m.

The cleaning machines in Elevator A were started for the night run at 7.00 p. m., and soon after starting the machines, one of the employees stepped to a door on the west side of the elevator and, looking out, saw sparks coming up through the dock. This employee immediately ran to the elevator foreman's office and notified him of the fire. By this time, flames were coming up through the dock and between the ends of the dock planks and the side of the elevator. The foreman notified the engineer at power house of the fire and telephoned the men in the upper stories of Elevator A to get out of the building. The foreman and others then laid lines of hose from the standpipes in the elevator, three or four being laid.

The Steamer Parent of the Great Lakes and St. Lawrence Transportation Co., which had been loading from Elevator A that day and was still lying alongside the dock, pulled away about this time and it was then seen that the fire was burning briskly under the dock and, by this time, had broken through into the main floor of the elevator and into the low unused and unsprinklered basement, the fire probably getting through the stone basement wall, through the wood vent spouts connected with cleaning machines, constructed as shown in Figure 34, of which there were ten. As soon as the fire got inside the elevator, the flames spread along the west side of the elevator rapidly, creating such a volume of smoke as to seriously handicap the inexperienced firemen, so that little was done with the private hose and the fire spread all along the west side, along the pockets under the bins, over the sprinklers. The sprinklers seemed to open readily but due to location and obstruction, the fire probably spread over or around them, advancing beyond them before being extinguished.

From the testimony of eye witnesses, it appears that the sprinklers held the fire at least an hour, it burning very slowly in the first floor, but

Fig. 34.



Sketch Showing Section Through Dock and Basement of Elevator A.
Fire spread through ventilating holes and spouts to basement.

when fire burned through bin bottoms it was beyond control. (See foot note at end).

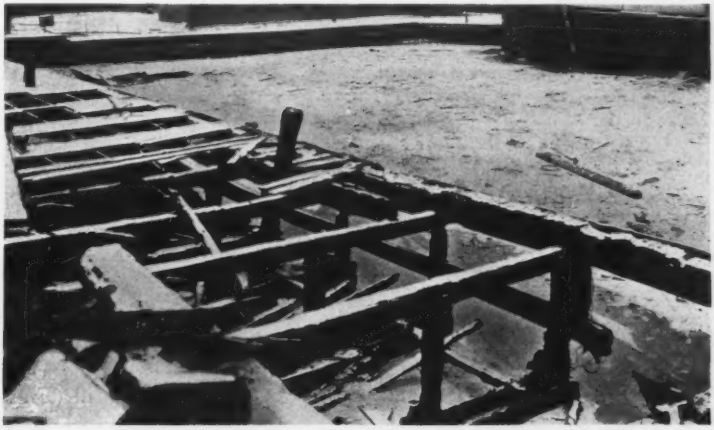
About 7.20 the chief of the Superior Fire Department, with two hose carts, arrived at the elevator. There are no city hydrants in the vicinity of the Great Northern Elevators, so the fire department laid two lines of hose from the private hydrants supplied by the Great Northern Elevator fire pumps, but the sprinklers and inside hose were taking so much water that the streams from the hydrants were of little value and by this time the smoke was so dense that the elevator could not be entered from the east side, where the hydrants are located.

On account of the roughness of the roads leading to the elevators, the fire engines had to be loaded on flat cars and did not arrive at the elevators until about 8.30, by which time the fire had gotten beyond control.

The tug Inman, not a regular fire tug, but carrying a large fire pump, arrived about 7.45 and was requested by the chief to moor to the south end of the dock and put a line of hose into the elevator, but, as the tug was a wooden vessel and the dock burning briskly, the captain declined to tie up but played on the fire through the doors and windows, but the streams had little effect. About 8.00 o'clock, the fire tugs American and Sinclaire arrived and proceeded to work. About 8.30 an explosion was heard and a few minutes later the entire top of Elevator A was a mass of flames. The explosion may have been from dust or may have been caused by the heat and gases generated by the fire burning through the bottom of an empty bin and confined in the bin, which was covered but not sprinklered inside, until the top was thrown off forcibly. The heat now became so intense that the Great Northern Warehouse, across the slip west of Elevator A, 175 feet distant, began to blaze at the doors and eaves and the efforts of the tugs were directed towards the warehouse, the tugs moving back and forth along the side of the warehouse and keeping streams of water on it. It was also necessary to keep streams of water on the tugs and the men operating the hose, on account of the intensity of the heat. Both tugs were badly scorched. Shortly after the arrival of the fire engines, the heat from Elevator A became so intense that the eaves of

Elevator X, 438 feet distant, began smoking and streams from the engine were thrown onto this elevator, this, with the aid of men inside who kept walls and floors adjacent to house wet with hose, prevented its destruction. The heat was also intense against the south end of the steel Elevator S, located 250 feet north of Elevator A, but men were stationed inside, who kept the wooden floors thoroughly wet with salt water stored in barrels in the various floors so that Elevator S sustained practically no damage beyond the cracking of the wired glass windows, although the heat was so intense that the tin on the metal-clad door in the top floor was melted. Some posts and braces in the bin floor of Elevator S are somewhat warped but this same condition exists in the north end, where the heat could not possibly have effected it, so it is believed that the warping was caused by wheat bulging the bins and causing unequal stresses.

When the top of Elevator A fell in, sparks and embers were carried onto the Globe Elevators Nos. 1 and 2 and docks 625 feet east of



Showing Construction of Dock on West Side of Elevator A, Beginning About 20 Feet South of the Elevator.

Elevator A, and it was only by the strenuous efforts of the superintendent and men at these elevators, assisted by the fire department, that these elevators were saved. Eight lines of hose were used in No. 1, three lines in No. 2 and two lines from hydrants to the dock; the hose inside being used mostly from the windows of the texas to form a water curtain and to extinguish brands as they fell on the buildings and the dock lines used to keep fire from getting under the buildings and docks.

Several small dwellings on the east side of Globe Elevator No. 2 were fired by flying brands, but the fires were extinguished by the fire department and fire thus prevented from getting into Lehigh Valley Coal

Dock Company's buildings. It is probable that had the fire gotten started in these, it would have been communicated to the Superior Manufacturing Company's building, the Buffalo Oil Company's building, and those south of them and thence to Tower Avenue, in which case, the greater part of the city would have been destroyed.

Shortly after the top of Elevator A collapsed, firebrands were carried to the Scale House of the St. Paul and Western Coal Dock Co. on Connor's Point, shown on map at Figure 27A, about 3,900 feet from Elevator A. This was soon followed by scores of fires all along Connor's Point, three houses and one barn being destroyed and many others damaged. An old boat, The Swain, lying in Howard's Pocket, near the bridge, was also destroyed by flying brands. One hose company and fire engine responded to the call from the St. Paul and Western Coal Dock Co. and prevented further serious damage on Connor's Point. Fires were also started at the Northern Coal Dock Company, shown at Figure 33, but were extinguished by the company's men before much damage was done.

Very shortly after the fire started at Connor's Point, the buildings of the Great Lakes Dock and Dredge Co., shown at Figure 14, were fired by brands from Elevator A, and about the same time one tug and four dredges lying in Tower Slip, shown at Figure 13, were fired and destroyed. Brands from Elevator A also lit on the roofs of the buildings of Duluth-Superior Storage Co., formerly Grand Republic Mill and Warehouse, shown at the Figures 17 and 18, and these brands, together with the sparks and heat from the Dredge Company's buildings, had these buildings beyond control before the fire department arrived.

When the fire was first discovered at Elevator A a very strong wind was blowing from a southwesterly direction, as shown on map by arrow west of Elevator A, driving the fire against the sides of the elevator and through the basement ventilator holes along the dock. Shortly after the fire crossed Tower Slip, the wind veered to a northwesterly direction, as shown on map by arrow at the mouth of Tower Slip. Fire was communicated from Grand Rapids Mill to Grand Republic Elevator (Figure 19) by sparks and radiant heat and from this to Minkota Mill (Figure 20) and from this to Minkota Elevator (Figure 21). Freeman Mill (Figure 24) was fired by radiant heat from Grand Republic Elevator. This, in turn, communicated fire by direct flames and radiant heat to Freeman Warehouse and Elevators (Figures 25 and 26). The Freeman Mill and Elevator were equipped with sprinklers but the equipments were substandard and as these risks were attached from the outside the sprinklers were of little, if any, value.

The buildings of Superior Manufacturing Co., shown at Figures 15 and 16, were fired several times by flying brands from Elevator A, and were saved only by the strenuous efforts of the superintendent and his men.

From the group of buildings on Hughitt Slip firebrands were carried to some dredges shown at Figure 27, which were but slightly damaged, and to the buildings of the Superior Ship Building Co. shown at Figure 32, the middle building being badly damaged. The fire here was extinguished by the Duluth Fire Department on its way to Connor's Point. The Duluth Fire Department responded to a call with two engines and two hose carts,

Showing the Ruins of Elevator A, Mostly Grain, and Dock.

Great Northern Railway Warehouse is seen at the extreme left, Elevator S in the left background and Globe Elevator No. 1 at the right background. This view was taken from top of building shown on map at Fig. 2.

but owing to the absence of the bridge between the two cities, which was wrecked over a year ago, and also the blockade of the railway at Elevator A, the department was obliged to come by a circuitous route and did not arrive until 1 a. m. and upon arrival proceeded to Connor's Point.

Firebrands were also carried from the buildings on Hughitt Slip to Rogers & Ruger Lumber Company's Yard, 5,200 feet away. This plant is not shown on map, but is located southeast from Hughitt Slip in a direct line with the slip and the Superior Ship Building Company's plant. The fire here was extinguished by the company's men before much damage was done.

A peculiar feature of the fire was in many instances flames and heat skipped structures of inflammable nature located in the path of the fire and destroyed only such buildings in which values were heaviest.

The property loss is approximately two and one half millions; the insurance loss about one and three quarters million dollars.

W. G. SANDERSON, *Chief Inspector,*
The Union.

Note.—Inspector Sanderson of the Western Union further states that had the sprinkler equipment in Elevator A been of modern design, he believes it would have controlled and eventually extinguished the fire. The chief defects seem to have been: first, and perhaps foremost, the lack of sprinklers in basement; second, the old-style spacing and arrangement around bottom of bins in first floor with interference from spouts and timbers; and third, the fact that a floor had been built on top of bins and there were no sprinklers underneath this floor. Furthermore, there were no curtain boards to stop draft and the general arrangement of the system was not in accordance with best modern practice. The water supplies were good and, as mentioned, the sprinklers seem to have materially retarded the fire but could not prevent its spread and finally the system was overtaxed.—Editor.

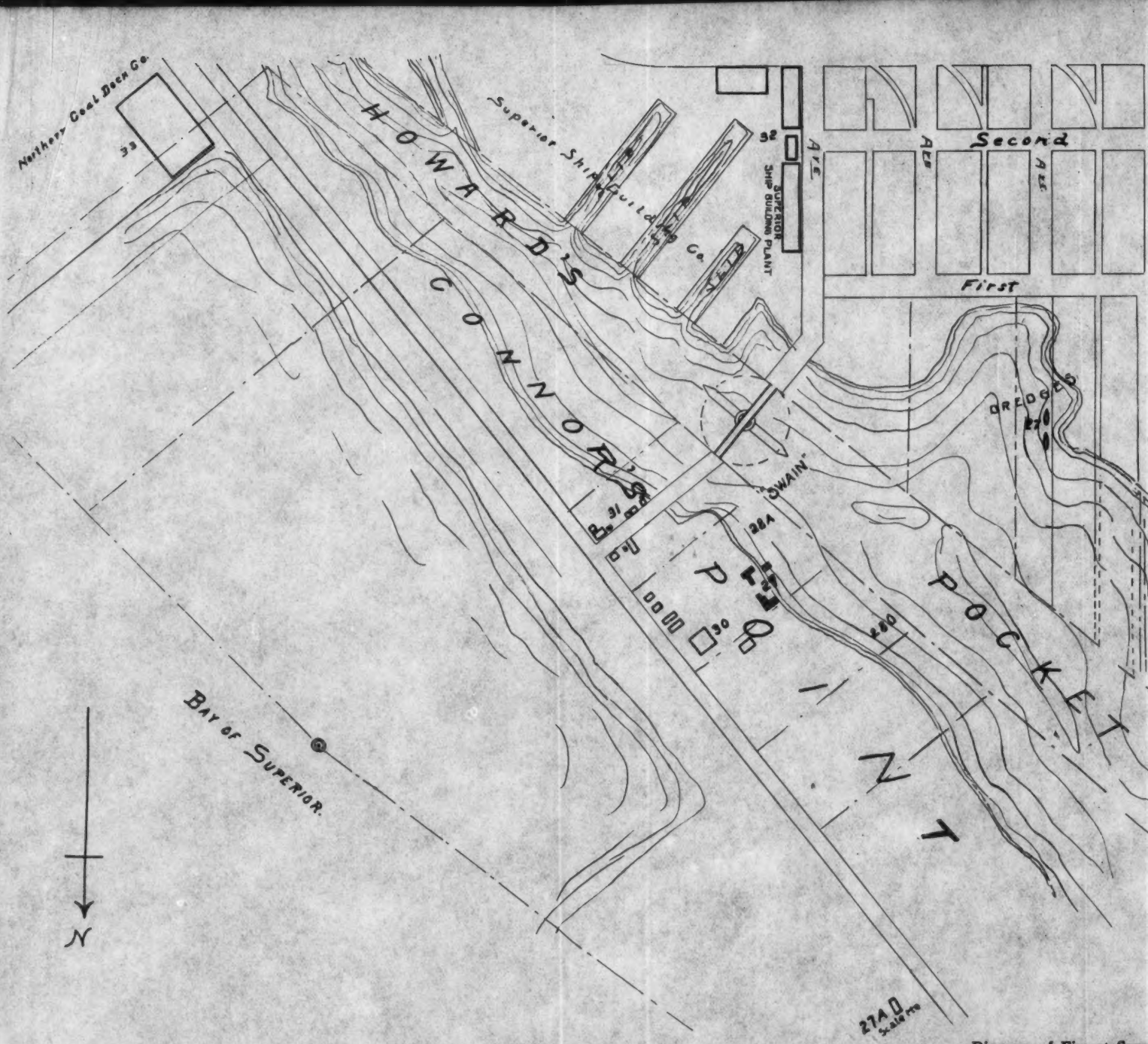


Diagram of Fire at Supe
Scale about 450 feet

t Superior, Wisconsin.
0 feet to one inch.

Editorials.

Engineering Library.—Members may not all be aware of the very complete and valuable engineering library which is now located in the Engineering Building, 29 West 39th Street, New York City. This library is open to all members of the National Fire Protection Association and we have recently received the following official invitation:

You are hereby officially notified that the Library of the Founder Societies in this building is open daily from 9 a. m. to 9 p. m. Members of your Society are cordially invited to make use of the privileges of the Library under the following regulations:

> "Members of your organization who desire to use the Library will apply before 5 p. m. to the Secretary of one of the Founder Societies for the regulation card of admission. In case application cannot be made until later than 5 p. m., proper credentials (either a membership card or a letter from the Secretary of the Associate Society) should be presented to the Librarian in charge."

Will you please include this notice in the publications sent to the members of your Society?

For the Library Committee,
JOS. STRUTHERS,
Chairman House Committee.

This library is probably the best and most complete of its kind in this country and members will undoubtedly find it exceedingly useful for reference and study.

Report of the Nominating Committee. At the last Annual Meeting the Nominating Committee recommended the following changes in the Articles of the Association. These will be acted upon at the next Annual Meeting and advance notice is hereby given.

Article No. 4, amended to read as follows:—

"Article 4. The officers shall be a President, a Vice-President, a Secretary and Treasurer and an Executive Committee of Fifteen.

"At the annual meeting in 1908 a President, a Vice-President and a Secretary and Treasurer shall be elected for one year, five members of the Executive Committee for three years, five members for two years, and five members for one year. At each succeeding annual meeting a President, a Vice-President and a Secretary and Treasurer shall be elected for one year, and five members of the Executive Committee for three years each."

4 A and B no change.

Add 4 C.

"All officers shall hold office until their successors are elected. Vacancies in office shall be filled by the Executive Committee until the next annual meeting when the Association shall fill the vacancy for the unexpired term in the same manner in which officers are elected."

Index of Special Hazard Bulletins. We have noticed a considerable demand for a detailed index which would cover the Quarterly Bulletins issued by the Committee on Special Hazards and Fire Record. The Committee issued 17 Bulletins in all, covering a large variety of special hazards and kindred matters, making a work of reference which must be exceedingly valuable to all those studying fires and their causes. The index has been bound in a similar size and manner to the present Quarterly and Proceedings with the feeling that this size was more convenient to handle. We have endeavored to make the index sufficiently in detail to be of real value in looking up any of the subjects treated in the Bulletins and hope that members will find it useful. With the exception of a few of the earlier numbers we have a fair supply of all the Bulletins on hand and can furnish these to members at the following prices:

Special	Hazard	Bulletins	Nos. 1, 2, 3, 5 each	$ .20
"	"	"	Nos. 4 and 6, (limited supply)	.50
"	"	"	No. 7	.30
"	"	"	No. 8	.35
"	"	"	No. 9	.20
"	"	"	Nos. 10, 11, 12, 13, 14, 15 each	.25
"	"	"	No 16	.30
"	"	"	No. 17	.25

The index does not cover the present Association Quarterly, the first number of which was published last July and it is our intention to provide a yearly index for the Quarterly covering the four numbers.

Fire Reports. It has often been remarked that the fire record is one of the most important branches of our Association work, and we are at the present time attempting to obtain reliable reports on all fires in certain classes of risks, particularly Sprinklered Risks, Manufacturing and Special Hazard Risks, Fire-Proof Buildings, Electrical Properties, etc. We desire that these reports be filled out on the regular Association blank and to that end we are prepared to furnish the printed blanks in any numbers desired.

When ordering blanks state number desired of each kind. Sprinklered Risks (white paper), Special Hazard Risks, (yellow paper), Fire-Proof Risks (brown paper.)

The difficulties attending the tabulation of reports which are simply written up consecutively and without using the special blank may be appreciated, and even with long reports, the blank may be used for the summary and a detailed report attached. In some sections of the country we have difficulty in securing fire reports and the co-operation of all our active members is especially desired.

Photographs, cuts or line drawings often add greatly to the proper understanding of the fire report, and we hope members will bear this in mind when reporting on important fires.

Committee Reports. We wish to again call attention to the Progress Reports from Committees and the opportunity that is offered to Committee Chairmen, to place before members the work that they have underway and prospective. These progress reports are not intended to be official but simply to bring our members as a whole in closer touch with committee work for the benefit of both. Most of our work is necessarily done through committees whose members constitute but a small part of our membership as a whole, and it would seem desirable for all of our committees to, if possible, keep in close touch with members and thereby obtain the benefit of any suggestions members have to offer.

Fire-Proof Power Stations. Members will doubtless be much interested in the article on "Fire-Proof Power Stations," particularly as showing the refinement to which risks of this class can be carried in an endeavor to prevent fires, and it has already been amply demonstrated that a risk of this character is both commercially feasible and practical. It is of course unnecessary to point out the importance from a standpoint of public utility of preventing interruptions to service from fire or other causes in power stations and this of course has had an important bearing on their development. The writer recently inspected a power station built of reinforced concrete where the feed wires were run in conduit imbedded in the concrete. Where wires have a combustible covering or insulation as is generally the case it would seem that running of wires in conduit was a desirable improvement for it is well known that short circuits have occurred in well-constructed stations, setting fire to wire insulation and doing considerable damage which could probably not have occurred had the wiring been in conduit. While Mr. Mackinney favors the running of cables in conduit inside of stations, he states that it meets with some objections from station engineers.

Approved Devices and Materials. Elsewhere in this issue is given a complete list of devices and materials approved by the National Fire Protection Association through its Committee on Devices and Materials. It is felt that a list of this kind may be very useful to members, especially those who deal with the installation of fire protection devices and who naturally wish to have at hand a list of approved apparatus. Particular attention is called to those classes of devices where the labelled service has been inaugurated and it should be noted that with those classes only labelled goods are approved. This labelled service is being continually extended to cover new classes, and we will bring all of this information before our members each quarter so that they may be kept posted.

Metal Worker Fire Record. We publish in this issue a fire record of Metal Workers which we think will be found particularly instructive. The record includes a total of 818 reports, which is considerably larger than the fire reports on other classes heretofore published and gives a better average. The causes of fire seem to be

more than ordinarily interesting and cover all of the well-recognized hazards, also many which are not as well understood. The importance of the oily waste hazard and other oily material is strongly emphasized and amounts to about 12% of the whole.

The more important special hazards are Forges, Hot Metal and Furnaces which together account for something over 15% of the whole. Also Japanning, Painting and Lacquering which figure about 12.% Among the less frequent causes of special interest may be noted breaking of nitric acid carboys, spontaneous ignition of steel chips and oil, oil tempering (14 fires), use of celluloid, spontaneous ignition of charcoal dust (3 fires), etc. The buffing hazard is shown to be of especial importance, with 29 fires or nearly 5% of the whole. The oily lint from the cotton buffing wheels is especially susceptible to spontaneous ignition. The record of metal workers is not supposed to include the mixed metal and wood workers such as agricultural implements, automobile factories, etc., but many metal workers have the woodworking hazard in their pattern shops, including perhaps a dry kiln and even a sawdust vault, and about 2% of all the fires come under this head.

Owing to the recent discussions as to the efficiency of watchman service it is interesting to note that about 30% of the fires were discovered by watchmen. Furthermore, the detailed tabulation of alarm service, which includes sprinklered risks only, shows that watchmen discovered 45 fires and failed to discover four fires, this not including such risks as had a sprinkler alarm or thermostats. Out of 41 cases where there was a sprinkler alarm, the watchman discovered the fire 20 times ahead of the sprinkler, while in the other 21 fires the sprinkler alarm notified either the watchman or someone else.

The effect of sprinklers in Metal Workers as a whole does not vary materially from the general average, although the percentage of unsatisfactory fires is a little less.

	All Classes.	Metal Workers.
Extinguished Fires	67	65
Held in Check	27	30
Unsatisfactory	6	5

Furthermore, the average number of sprinklers opened (in successful fires only) is but little less, being 6.0% against 7.3% for all classes so far reported upon.

In Table 14, it will be noted that the automatic pump shows up poorly as to average number of sprinklers opened. This does not reflect on the automatic pump, but is due to three fires where a large number of heads opened from causes other than water supply or pressure. Referring to the percentage of unsatisfactory fires, the automatic pump has a clean record and superior to any other supply, the pressure tank having the next best record with 2% unsatisfactory.

Table 15 shows that pressures below 15 pounds are less reliable, there being 14% unsatisfactory fires against only 4% for pressures over 50 pounds.

Table 16 shows a much larger average number of sprinklers opened for the dry system (i. e. 11 against 4½), but when it comes to

efficiency of the two systems there is but little difference, being 5% unsatisfactory for wet systems and 7% for dry systems.

High Pressure Fire System for New York City.—The magnitude of this undertaking is probably not generally appreciated and the following data may be of interest. The enormous values in the congested district of New York City make it feasible to spend a large amount of money on fire protection and even the four million dollars which will be spent on this new service is a small factor when compared to the property value at stake.

The system as completed to date comprises 53 miles of pipe, varying from 12 to 24 inches, and covers an area of about 1,400 acres, extending from Twenty-third Street on the north to Chambers Street on the south, and from the Hudson River on the west to the Bowery on the east. There are 1,100 hydrants now in place and about 200 more will be installed as soon as the weather permits the opening of work in the spring. The Croton water has been connected at the upper end with these pipes, and about two-thirds of the system is now filled with "sweet" water under, of course, only ordinary pressure; but its presence enables all of the hydrants supplied with it to be used by the fire engines in case of need. When the pumps are completed (which probably will not be until next summer at the earliest) they will be primarily fed by Croton ("sweet") water, and the system will be kept filled with such water under a pump pressure of 100 pounds, but when any heavier pressure is called for the pumps will draft from the salt water intakes, and the pressure will be increased to as high as 300 pounds, if required. The two pumping stations—one located at the foot of Gansevoort Street on the Hudson River and one at South and Oliver Streets on the East River—will have a total capacity of 30,000 gallons per minute. The pumps in these stations are to be electrically driven. The entire system when completed will cost about $3,900,000.

Secretary's Report, Branch Offices, and Underwriters' Laboratories.

By direction of the Executive Committee (action November, 1907) we list below in form convenient for reference by members the names and addresses of manufacturers of devices and materials which have thus far been favorably passed upon by the Committee of Devices and Materials, following examinations, tests and recommendations made by Underwriters' Laboratories, Inc.

The Laboratories have also issued reports giving ratings unfavorable to a large number of appliances. A summary of the findings in each case can be obtained by addressing the Laboratories and any Active or Associate member can receive regularly the cards issued by the Laboratories giving summaries of the results obtained in the current work in all of its departments upon payment of the subscription price of fifteen dollars ($15) per year.

In the lists which follow members should note particularly that in those industries to which the label service has been extended (indicating inspection of goods by Laboratories' engineers at factories before shipment), that **only such of the product of these factories as bear the labels referred to** are covered by the endorsement of our Committee.

CARBONIC ACID GAS HAND FIRE EXTINGUISHERS.

Carbonic Acid Gas Hand Fire Extinguishers constructed in accordance with National Fire Protection Association specifications and examined and tested at factories under the supervision of Underwriters' Laboratories, Inc., have metal labels soldered to the front of the cylinders reading:

The following companies are equipped to supply these devices. Members are advised to give preference to extinguishers which bear the labels referred to.

Boston, Badger Fire Extinguisher Co., 32 Portland Street.
Boston, Knight & Thomas, 99 State Street.
Buffalo, Western Inspection Co., 45 N. Division Street.

Chicago, Miller Chemical Engine Co., 149 E. Huron Street.
Cincinnati, Harker Mfg. Co., 118 W. Second Street.
Elmira, N. Y., American-LaFrance Fire Engine Co., Elmira.
Newark, N. J., The Tea Tray Company of Newark, N. J., Mulberry and Murray Streets.
Philadelphia, James Boyd & Bro., 14 North Fourth Street.
Philadelphia, National Inspection Co., 416-422 Sansome Street.
Pittsburg, Fire Extinguisher & Supply Co., 1414-1422 Spring Garden Avenue, N. S.
Pittsburg, Pittsburg Lamp, Brass & Glass Co., Pittsburg.
St. Louis, Frank & St. Gemme Mfg. Co., 815-817 Market Street.
St. Louis, Missouri Lamp and Mfg. Co., 116 Elm Street.
St. Louis, Stempel Fire Extinguisher Co., 4250 North 20th Street.
Toronto, Canada, Canadian Underwriters' Fire Appliance Co., 27 Wellington Street, E.
Utica, O. J. Childs Co., 50 Liberty Street.

DOORS.

N. F. P. A. Standard 2½ inch metal clad.

Doors of this class constructed in accordance with National Fire Protection Association specifications and examined and tested at factories under the supervision of Underwriters' Laboratories, Inc., are labeled by stampings in the tin plates or by attaching brass labels reading:

The following companies are equipped to supply these devices. Members are advised to give preference to doors which bear labels referred to.

Cleveland, Riester & Thesmacher Co., 325-329 Pearl Street.
Newburyport, Victor Manufacturing Co.
New Orleans, American Sheet Metal Works, Carrollton Avenue and Edinburg Street.
New York, Howell & Lawrence, 1788 First Avenue.

Corridor or Partition Doors. (Not for openings in fire walls.)

Doors of this class constructed in accordance with National Fire Protection Association specifications and examined and tested at factories under the supervision of Underwriters' Laboratories, Inc., have labels screwed or riveted to the edge of the door reading:

The following companies are equipped to supply these devices. Members are advised to give preference to doors which bear the labels referred to.

Jamestown, N. Y., Dahlstrom Metallic Door Co., Jamestown.
Minneapolis, Minn. Northwestern Roofing, Cornice and Stamping Works, 113 S. Fifth Street.
Minneapolis, Minn. Fireproof Door Co., 1600-1616 Central Avenue.
New York, Howell & Lawrence, 1788 First Avenue.
New York, Manhattan Fire Proof Door Co., 412-422 E. 125th Street.
New York, J. F. Blanchard Co., Fuller Bldg.

Stair or Elevator Doors. (Not for openings in fire walls.)

Doors of this class constructed in accordance with National Fire Protection Association specifications and examined and tested at factories under the supervision of Underwriters' Laboratories, Inc., have labels screwed or riveted to the edge of the door reading:

The following companies are equipped to supply these devices. Members are advised to give preference to doors which bear labels referred to.

Jamestown, N. Y., Dahlstrom Metallic Door Co., Jamestown.
Minneapolis, Minn., Northwestern Roofing, Cornice and Stamping Works, 1113 S. Fifth Street.
Minneapolis, Minn. Fireproof Door Co., 1600-1616 Central Avenue.
New York, J. F. Blanchard Co., Fuller Bldg.
New York, Howell & Lawrence, 1788 First Avenue.
New York, Manhattan Fire Proof Door Co., 412-422 E. 125th Street.

DOOR AND SHUTTER HARDWARE.

3½ x ⅜ Hardware for Sliding Doors only.

Hardware of this class constructed in accordance with National Fire Protection Association specifications and examined and tested at factories under the supervision of Underwriters' Laboratories, Inc., have labels attached to each hanger, binder and stay roll of each set reading:

A tag is also attached to one hanger of each set on which is printed a list of the pieces which a complete set should contain, as follows:

1. **One 3½x⅜ inch track, length to be equal to twice the width of door opening plus 21 inches. Punched for wall bolts.**
2. **Two hangers for openings 6 feet and less in width, three hangers for openings wider than 6 feet. Bolts for attaching hangers to door.**
3. **Two 3½x⅜ inch binders.**
4. **One 2x½ inch stay roll.**

Stay roll should be the type specified for the form of sill used, and should include all bolts except wall bolts.

5. **One cast iron bracket for each track bolt.**
6. **Two ¾x¼ inch half oval chafing strips for back of door, two 1x⅛ inch flat strips for front of door opposite the oval strips. Bolts for fastening above strips together through door. Length of above strips to be 4 inches less than door opening.**
7. **One 1½x⅛ inch strip 5 inches less than width of door to take wear of stay roll. Wood screws for attaching.**
8. **One wedge with screws for attaching.**
9. **One bow shaped handle and one flush pull with bolts and screws for attaching.**
10. **One front bumper and one back bumper.**
11. **Four bumper shoes and screws for attaching.**
12. **One washer for each wall bolt, including those for binders and stay roll.**
13. **One instruction card for mounting.**

Where the hardware for a single fire door on each side of the fire wall is bolted together through the wall, the washers above specified are unnecessary.

Wall bolts are not included as the requirements for length varies in each case. Automatic attachments are not as yet included in a standard set of hardware.

The following companies are equipped to supply these devices. Members are advised to give preference to hardware which bears the labels referred to.

Aurora, Ill., Richard Mfg. Co., Aurora.
Aurora, Ill., Wilcox Mfg. Co., Aurora.
Philadelphia, James Peters & Sons, 1934-38 North Front Street.
Newburyport, Mass., Victor Manufacturing Co.

Specially Designed, Malleable Iron Hardware for Sliding Door Only.

Hardware of this type which is considered to be the full equivalent of the 3½ x ⅜ hardware made in accordance with National Fire Protection Association specifications, and examined and tested at factories under the supervision of Underwriters' Laboratories, Inc., have labels attached to each hanger, binder and stay roll of each set reading:

(*See label under hardware for sliding doors.*)

A tag is also attached to one hanger of each set on which is printed a list of the pieces which a complete set should contain, as follows:

1. **One 1 7-16 inch tubular track, length to be equal to twice the width of the door opening, plus 14 inches.**
2. **Two hangers for openings six feet and less in width; three hangers for openings wider than six feet. Bolts for attaching hangers to door.**
3. **Two malleable iron binders.**
4. **One malleable iron stay roll.**
5. **Brackets to carry track, including two special end supports.**
6. **Two ¾x¼ inch half oval chafing strips for back of door, two flat strips for front of door opposite the oval strips. Bolts for fastening above strips together through the door. Length of above strips to be 4 inches less than door opening.**
7. **One 2¼x⅛ inch strip 5 inches less than width of door to take wear of stay roll. Wood screws for attaching.**
8. **One steel wedge with screws for attaching.**
9. **One bow shaped handle and one flush pull with bolts for attaching.**
10. **One front bumper and one back bumper.**
11. **Four bumper shoes and screws for attaching.**
12. **One washer for each wall bolt, including those for binders, bumpers and stay roll.**

Where the hardware for a single fire door on each side of the fire wall is bolted together through the wall, the washers above specified are unnecessary.

Wall bolts are not included as the requirements for length vary in each case. Automatic attachments are not as yet included in a standard set of hardware.

UNDERWRITERS' LABORATORIES, Inc.,
382 Ohio St., Chicago.

The following company is equipped to supply these devices. Members are advised to give preference to hardware which bears the labels referred to.
Chicago, Allith Manufacturing Co., Taylor Street and 43rd Avenue.

FIRE DOORS. (See Doors.)

GLASS. (See Wired Glass.)

HARDWARE. (See Door and Shutter, Hardware.)

HOSE.

2½ Inch Cotton Rubber-Lined.

Private Department Fire Hose for outside use constructed in accordance with National Fire Protection Association specifications and examined and tested at factories under the supervision of Underwriters' Laboratories, Inc., have attached to each 50 foot length label reading:

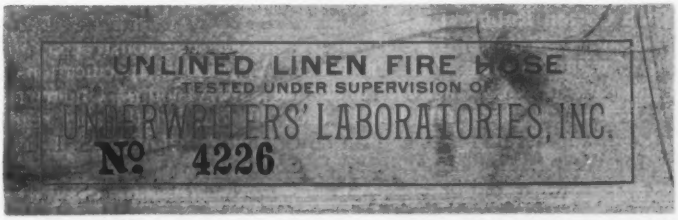
The following companies are equipped to supply this material. Members are advised to give preference to hose which bears the label referred to.
Akron, O., B. F. Goodrich Co., Akron.
Boston, Boston Woven Hose and Rubber Co., P. O. Box 5077.
New York, Eureka Fire Hose Co., 13 Barclay Street.
New York, Manhattan Rubber Mfg. Co., 18 Vesey Street.
New York, New York Belting and Packing Co., Ltd., 91 Chambers Street.
New York, Fabric Fire Hose Co., Corner Duane and Church Streets, Elkshead.

Before the extension of the label service to this industry approvals were granted to certain brands of hose manufactured by the foregoing and other companies as follows:
American, Boston Belting Co., 256 Devonshire Street, Boston, Mass.
G. P. Gutta Percha and Rubber Mfg. Co., 126 Duane Street, New York.
Guttaperch, Gutta Percha and Rubber Mfg. Co. of Toronto, Ltd., 47 Yonge Street, Toronto, Ont.
Security, Revere Rubber Co., Chelsea, Mass.

Star, Canadian Rubber Co., Notre Dame Street and Papineau Avenue, Toronto, Ont.
Tuebor, New Jersey Car Spring and Rubber Co., Wayne and Brunswick Streets, Jersey City, N. J.
2-X-L, Mechanical Rubber Co., Cleveland, O.

HOSE, Unlined Linen.

Unlined Linen Fire Hose for use inside buildings constructed in accordance with National Fire Protection Association specifications and examined and tested at factories under the supervision of Underwriters' Laboratories, Inc., has attached to each length label reading:



The following company is equipped to supply this material. Members are advised to give preference to hose which bears the label referred to.
New York. Eureka Fire Hose Co., 13 Barclay Street.

PAINTS, FIRE RETARDANT.

The so-called "cold water" paints listed below have been examined and tested.

These coatings for wood and other similarly combustible building materials which come under this class, or property so coated, should in no sense be considered as "fire-proof." Their use is preferable to leaving the material uncoated because they retard the spread of fire over combustible surfaces and are particularly desirable in lieu of varnish, shellac, or oil finish, which latter serve to rapidly spread fire. Attention is called, however, to the need of renewal of the coatings in order to maintain the desired conditions.

Whitewash so well meets the requirements of this class that we print formula recommended by the Lighthouse Board of the United States Treasury Department as follows:

"Slake one-half bushel of unslaked lime with *boiling* water, keeping it covered during the process; strain it and add a peck of salt dissolved in warm water; three pounds of ground rice, put in boiling water and boil to a thin paste; one-half pound powdered Spanish whiting and a pound

of clear glue dissolved in hot water; mix these well together and let the mixture stand for several days. Keep the wash thus prepared in a kettle or portable furnace, and when used put it on as hot as possible with painter's or whitewash brushes."

Where possible the coatings should be applied by a hand brush rather than by a spraying machine, thus effecting a better surface, and special care should be exercised not to coat sprinkler heads where installed.

Carey's. Manufactured by The Neptune Paint Co., Hudson, Mich., for The Philip Carey Mfg. Co., Cincinnati, O.

Decorine. Manufactured by Benj. Moore & Co., 111 N. Green Street, Chicago.

Hygienic Fireproof Calcimine. Manufactured by The Rubber Paint Co., 154 W. Van Buren Street, Chicago.

Indeliblo. Manufactured by The Muralo Co., New Brighton, S. I., N. Y.

Indurine. Manufactured by The Muralo Co., New Brighton, S. I., N. Y.

J. M. Manufactured by The Neptune Paint Co., Hudson, Mich., for H. W. Johns-Manville Co., Milwaukee, Wis.

Kimaco. Manufactured by The Muralo Co., New Brighton, S. I., N. Y., for Kimbark-McCarthy Co., Chicago.

K'Sene. Manufactured by The Muralo Co., New Brighton, S. I., N. Y., for Western Roofing and Supply Co., Chicago.

Lythite. Manufactured by The Muralo Co., New Brighton, S. I., N. Y.

Magnite. Manufactured by The Muralo Co., New Brighton, S. I., N. Y., for J. A. & W. Bird & Co., Boston.

Monarch. Manufactured by Geo. Fletcher & Co., 49-51 N. Ashland Avenue, Chicago.

Nepolite. Manufactured by The Neptune Paint Co., Hudson, Mich.

Retardo. Manufactured by Benj. Moore & Co., Chicago, for Retardo Fire Proof Paint Co., Milwaukee, Wis.

Stay-There. Manufactured by The Neptune Paint Co., Hudson, Mich., for The Hardie Mfg. Co., Hudson, Mich.

ROOFINGS.

Certain proprietary roofings listed below have been examined and tested.

These tests indicate that the fire retardant properties of these materials are inferior to those of slate, metal or good tin-clad roofs, but in a class with those of good slag and good gravel roofs, and superior to those of wooden shingle roofs.

Protection Brand Asphalt Ready Roofing (Prepared), Asphalt Ready Roofing Co., 136 Water Street, New York.

Carbonite (Prepared, 2 and 3 ply), The Heppes Co., 2427 Fillmore Street, Chicago.

Carey's Standard Magnesia Flexible Cement (Prepared), The Philip Carey Mfg. Co., Lockland, Cincinnati, O.

Congo (Prepared, 2 and 3 ply), The Buchanan-Foster Co., 504 West End Trust Bldg., Philadelphia, Pa.

Eclipse Rubber (Prepared), Ford Manufacturing Co., Washington and Desplaines Streets, Chicago, Ill.

Ehrets (Slag), Warren-Ehret Co., 1202 Land Title Bldg., Philadelphia.

Elaborated Ready (Prepared), Elaborated Ready Roofing Co., 4419 La Salle Street, Chicago.

Flexo (Prepared, 2 and 3 ply), The Heppes Co., 2427 Fillmore Street, Chicago.

Galvanized Rubber (Prepared), Ford Manufacturing Co., Washington and Desplaines Streets, Chicago, Ill.

Genasco Asphalt Composition (4 ply), Barber Asphalt Paving Co., 1243 Stock Exchange Bldg., Chicago.

Genasco (Prepared Smooth Surface, 2 and 3 ply, Stone Surface, Whitestone and Model, 2 ply), The Barber Asphalt Paving Co., 1243 Stock Exchange Bldg., Chicago.

Granite (Prepared), The Eastern Granite Roofing Co., 1 Hudson Street, New York, N. Y.

Huttig Rubber (Prepared, 2 and 3 ply), Barber Asphalt Paving Co., 1243 Stock Exchange Bldg., Chicago, for Huttig Mfg. Co., Muscatine, Iowa.

Indruroid (Prepared, 2 and 3 ply), H. F. Watson Co., Erie, Pa.

Malthoid (Prepared, 2 and 3 ply), The Paraffine Paint Co., Merchants Exchange Bldg.

Mastic (Prepared), National Mastic Roofing Co., San Francisco, and National Roofings and Materials Co., Edwardsville, Ill.

Mikado (Prepared, 2 and 3 ply), J. A. & W. Bird & Co., 35 India Street, Boston.

No-Tar (Prepared, 2 and 3 ply), The Heppes Co., 2427 Fillmore Street, Chicago.

Paroid (Prepared, 2 and 3 ply), F. W. Bird & Son, East Walpole, Mass.

Rex Flintkōte (Prepared, 2 and 3 ply), J. A. & W. Bird & Co., 35 India Street, Boston.

Rhinoceros (Prepared, 2 and 3 ply), Warren Chemical and Manufacturing Co., 17 Battery Place, New York.

Roofrite (Prepared), The Lehon Co., W. 43rd Street, Lincoln to Robey, Chicago.

Rubber (Prepared, 2 and 3 ply), The General Roofing Co., East St. Louis, Ill.

Rubbertex (Prepared, 2 and 3 ply), The Heppes Co., 2427 Fillmore Street, Chicago.

Ruberoid (Prepared, 2 and 3 ply), Standard Paint Co., 100 William Street, New York.

Safety (Prepared), National Roofing Co., Tonawanda, N. Y.

Security (Prepared), National Roofing Co., Tonawanda, N. Y.

Standard Asbestos (Prepared), H. W. Johns-Manville Co., 100 William Street, New York.

Vulcanite (Prepared 2 and 3 ply), The Patent Vulcanite Roofing Co., 625 S. Campbell Avenue, Chicago.

Walrus (Prepared, 2 and 3 ply), Warren Chemical and Manufacturing Co., 17 Battery Place, New York.

West Coast Ready Rock (Prepared), The West Coast Company, Waukegan, Ill.

SHUTTERS. (See Doors.)

SPRINKLERS, Automatic.

It has not been judged necessary as yet to extend label service to these devices.

The following patterns are approved:

Grinnell Improved 1903. General Fire Extinguisher Co., Providence, R. I.

International, Evans 1902 Model. International Sprinkler Co., 517 Arch Street, Philadelphia, Pa.

Manufacturers "C". Manufacturers' Automatic Sprinkler Co., 48-50 Liberty Street, New York.

Neracher Improved 1902. General Fire Extinguisher Co., Providence, R. I.

Niagara-Hibbard, issue B, 1904. Niagara Fire Extinguisher Co., Akron, O.

Phoenix, issue A, 1905. Phoenix Fire Extinguisher Co., 1028-33 First National Bank Bldg., Chicago.

Rockwood, issue A. Worcester Fire Extinguisher Co., 4 Arch Street, Worcester, Mass.

SPRINKLER SUPERVISORY DEVICES.

For use in connection with approved central station systems.

Consists of apparatus for transmitting signals when gate valves are closed or opened; when water in tanks falls below or is restored to predetermined level; when pressure in air tanks falls below or is restored to predetermined amount; when water in tanks falls below or rises above predetermined temperatures. Also apparatus for connection with water flow valves to transmit water flow signals (where there is a flow of water equal to that of one or more sprinklers) and to withhold signals from water surges or variable pressure.

A. D. T. Devices for attaching to Central Station Signaling Systems for supervisory maintenance and operation of sprinkler equipments. Manufactured by Automatic Fire Protection Company, New York and Chicago.

VALVES, ALARM. (See also Sprinkler Supervisory Devices.)

No appliances meeting all of the requirements desirable for this service have as yet been shown.

Ratings covering the patterns found in common use have been issued as follows:

Evans Variable Pressure 1902 model. Manufactured by International Sprinkler Co., 517 Arch Street, Philadelphia. Not standard. Field experience limited, but fairly satisfactory where device has been properly installed, correctly adjusted and intelligently supervised.

Grinnell English Pattern, Variable Pressure (Swing check or Straightway type). Manufactured by General Fire Extinguisher Co., Providence, R. I. Not standard. Field experience fairly satisfactory where device has been properly installed, correctly adjusted and intelligently supervised.

Grinnell branch (old type called Harkness Tee). Manufactured by General Fire Extinguisher Co., Providence, R. I. Not standard. Field experience, where central station and Local Board supervision obtains and valves are under constant pressure, reported as fairly satisfactory.

Manufacturers'. Manufactured by Manufacturers Automatic Sprinkler Co., 48-50 Liberty Street, New York. Not standard. Field experience with an improved type of this valve in one locality, where central station and Local Board supervision obtains and valves are under constant pressure, reported as fairly satisfactory.

Niagara. Manufactured by Niagara Fire Extinguisher Co., Akron, O. Not standard. Field experience with an improved type of this valve in one locality, where central station and Local Board supervision obtains and valves are under constant pressure, reported as fairly satisfactory.

VALVES, DRY PIPE.

Following the continued effort of the Committee on Devices and Materials to secure improvements in this class of device manufacturers have improved patterns in process of construction, which when ready for the market may be distinguished by labels reading:

APPROVED DRY PIPE VALVE
No. 123456,
UNDERWRITERS' LABORATORIES, INC.

The following companies have shown plans or models, or both, for such valves:

Ashton Valve Co., 271 Franklin Street, Boston, Mass.
General Fire Extinguisher Co., Providence, R. I.
International Sprinkler Co., 517 Arch Street, Philadelphia, Pa.
Manufacturers' Automatic Sprinkler Co., 48-50 Liberty Street, New York.
Niagara Fire Extinguisher Co., Akron, Ohio.
Phoenix Fire Extinguisher Co., 1028 1st Nat'l. Bank Bldg., Chicago.

The older forms of these devices formerly approved were:

Grinnell. General Fire Extinguisher Co., Providence, R. I.
Grinnell Straightway. General Fire Extinguisher Co., Providence, R. I.
International (No 2 Evans Model). International Sprinkler Co., Philadelphia.
Manufacturers. Manufacturers' Automatic Sprinkler Co., 48-50 Liberty Street, New York.

WATCHMEN'S TIME RECORDING APPARATUS.

Boxes for Central Station Systems.

Combined watchmen's Call and Fire Alarm Boxes for use in connection with approved normally closed circuit Central Station Watchmen's Time Recording Apparatus, constructed in accordance with National Fire Protection Association specifications and examined and tested at factories under the supervision of Underwriters' Laboratories, Inc., have labels fixed to the outside of clock cases reading:

The following companies are equipped to supply these devices:
American District Telegraph Co., 195 Broadway, New York.
Chicago Electric Protective Co., 147 Fifth Avenue, Chicago.
Signalphone Co., Milwaukee, Wis.

Before the extension of the label service to this industry approvals were granted to certain boxes manufactured by the foregoing and one other company as follows:
Viaduct Mfg. Co., 10 S. Howard Street, Baltimore, Md.

Apparatus for Local or Private Systems.

Watchman's Stationary Clocks constructed in accordance with National Fire Protection Association specifications and examined and tested at factories under the supervision of the Underwriters' Laboratories, Inc., have label fixed to the outside of clock cases reading:

and a decalcomania transfer is applied to the outside of the magneto cases reading:

The following companies are equipped to supply these devices:
American Watchman's Time Detectors Co., 2069 Fourth Street, Cleveland, O.
American Watchman's Time Detectors Co., 234-5 Broadway, New York.
Eco Magneto Clock Co., 289 Congress Street, Boston.
E. A. Hamilton & Co., Grand Rapids, Mich.
Holtzer-Cabot Electric Co., Brookline, Boston, Mass.
E. Howard Clock Co., 373 Washington Street, Boston, Mass.
Newman Clock Co., (Single Station Clock), Masonic Temple, Chicago.
Simplex Time Recorder Co., Gardner, Mass.

Before the extension of the label service to this industry approvals were granted to certain clocks manufactured by the foregoing and other companies as follows:
Indianapolis Magneto. Indianapolis Watchman Clock Co., Indianapolis, Ind.
Wakeman's Single Station. Wakeman's Time Recorder Co., Scranton, Pa.

Portable Clocks.

Watchman's Portable Clocks constructed in accordance with National Fire Protection Association specifications and examined and tested at factories under the supervision of Underwriters' Laboratories, Inc., have labels fixed to the inside of clock cases reading:

(*See cut under Local or Private Systems.*)

and a decalcomania transfer is applied to outside of the key boxes reading:

(*See cut under Local or Private Systems.*)

The following companies are equipped to supply these devices:
Eco Magneto Clock Co., 289 Congress Street, Boston.
Hardinge Bros., 1034-1036 Lincoln Avenue, Chicago.
E. O. Hausburg, 45 Maiden Lane, New York.
Nanz & Co., 127 Duane Street, New York.
Newman Clock Co., Masonic Temple, Chicago.
The Timekeeper Co., Chicago.

Before the extension of the label service to this industry approvals were granted to certain clocks manufactured by the foregoing and one other company as follows:
New York. Manufactured by J. Schlenker, Germany, for The General Watchman's Time Detectors Co., New York.

WINDOWS.

Metallic Window Frames and Sash glazed with Wired Glass, constructed in accordance with National Fire Protection Association specifications and examined and tested at factories under the supervision of

Underwriters' Laboratories, Inc., have labels riveted to the inside of the window reading:

The following companies are equipped to supply these devices. Members are advised to give preference to windows which bear the labels referred to.

Boston, E. B. Badger & Sons Co., 63-9 Pitts Street. Double Hung Casement.

Chicago, Knisely Bros., 5th Avenue and 28th Place. Double Hung Pivoted.

Chicago, Harry C. Knisely Co., 273 S. Canal Street. Double Hung Pivoted.

Chicago, J. C. McFarland & Co., 27th Street and Fifth Avenue. Double Hung Pivoted.

Chicago, Jas. A. Miller & Bro., 129 S. Clinton Street. Pivoted.

Chicago, E. A. Rysdon & Co., 627-629 W. 41st Street. Double Hung Pivoted.

Chicago, Sykes Steel Roofing Co., 112-120 W. 19th Street. Double Hung Pivoted.

Chicago, Voigtmann & Co., 42-54 E. Erie Street. Double Hung Pivoted.

Cincinnati, Thomas Lee, 128 W. Second Street. Double Hung Pivoted.

Cincinnati, Witt & Brown, 215 W. 3rd Street. Pivoted.

Cleveland, Riester & Thesmacher Co., 325-329 Pearl Street. Pivoted.

Kansas City, Henry Weis Cornice Co., 1811-15 Wyandotte Street. Pivoted.

Kansas City, Zahner Manufacturing Co., 12 W. 10th Street. Double Hung Pivoted.

New York, Voigtmann & Co., 427 W. 13th Street. Pivoted.

Philadelphia, David Lupton's Sons Co., Allegheny Avenue and Tulip Street. Casement Double Hung Pivoted.

Philadelphia, J. S. Thorn Co., 20th Street and Allegheny Avenue. Double Hung Pivoted.

Salem, O., W. H. Mullins Co., Salem. Double Hung.

St. Louis, Mesker & Bro., 421-519 S. 6th Street. Double Hung.

St. Louis, Mo., Eagle Metal Works, 510-512 Clark Avenue. Double Hung.

WIRED GLASS.

It has not been judged necessary to extend label service to this material up to the present time. Distinctive marks applied by the companies themselves to that portion of their product constructed in accordance with the standard (without constant supervision of such marking by the Laboratories) has been considered acceptable.

New York, N. Y. Mississippi Wire Glass Co.,

This company claims exclusive right to the use of hexagonal mesh in wired glass. Decision of the Court of last resort on this claim is not yet obtained. In the meantime sub-standard wired glass using hexagonal mesh is occasionally found on the market. Members should therefore make careful inspection of this type of product before acceptance.

Philadelphia, Pa. Continuous Glass Press Co.,

Marking: Consists of a strand of the wire mesh made by twisting two No. 27 gage wires together, and spacing such distinctive cabled strand approximately 10 inches apart in each sheet of glass manufactured.

Streator, Ill. Western Glass Co.

Marking: Consists of five loops at each vertical strand of wire mesh.

W. H. MERRILL, *Secretary.*

The attention of all Active and Associate Members has not recently been called to the advantages to be obtained from receiving regularly reports from the Underwriters' Laboratories covering examinations and tests of devices and materials. The following cuts indicate the manner in which these devices are promulgated on cards arranged for ready reference. The Laboratories are issuing at the present time reports on from 100 to 150 devices per month. The price for subscription to this service is $15 per year, and subscriptions are open to all Active and Associate Members of the National Fire Protection Association.

1491—Aug. 28, 1907

.....Name.....

.....Location.....

RHEOSTATS

Porcelain tubes wound with resistance coils and covered with cement. With or without sheet iron cases.

APPROVED when suitably mounted on bases of non-combustible material.

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.....Name.....

.....Location.....

WINDOW

Metallic window frames and sash glazed with wired glass, constructed in accordance with the latest specifications of the National Board of Fire Underwriters and examined and tested at factories under the supervision of Underwriters' Laboratories, Inc., have labels riveted to the inside of the window reading:

"Window Frame for Wired Glass, constructed under supervision of Underwriters' Laboratories, Inc., No....."

This company is equipped to supply these devices in the following pattern:

Pivoted Upper Sash

Users and Underwriters having jurisdiction are advised to give preference to windows which bear the labels referred to.

These are approved for protection against moderate exposures in openings not exceeding 5 ft. by 9 ft. (Underwriters having jurisdiction to be consulted before installation.)

FACTORY INSPECTION SERVICE.

Inspectors employed by Underwriters' Laboratories, Inc., visit this factory as often as occasion requires (every few days in busy seasons), examine windows in process of construction and those ready for shipment.

UNDERWRITERS' LABORATORIES.

The Underwriters' Laboratories have recently issued a very complete pamphlet giving general information as to the nature of their work and terms and conditions under which they conduct their tests of fire appliances and materials. The pamphlet shows some excellent cuts of the various rooms and testing appliances, and copies can be obtained by writing W. H. Merrill, Jr., Secretary, 382 Ohio Street, Chicago, Ill.

Feeling that some of the information contained in this pamphlet may be of general interest to our members we quote as follows:

5. Character of Work.—As is indicated by the foregoing the work of Underwriters' Laboratories, Inc., is confined to investigations having a bearing upon the fire hazard. The corporation is not in business for profit, and its findings are in all cases subjected to review by committees of expert engineers appointed for the purpose by organizations which have been successful in fixing upon and securing the general recognition of correct solutions of many of the problems presented by the enormous and disproportionate destruction by fire of property in the United States.

6. Manufacturer or Owner of Fire Appliances.—Under the generous patronage of the organizations standing as sponsor for it, Underwriters' Laboratories, Inc., has during the few years of its existence proven itself a factor of value in this concerted effort for the general good, by aiding to determine experimentally the measure of protection or of hazard afforded by various devices, systems and materials found in or proposed for use. The manufacturers of such appliances have co-operated in this effort by partially defraying the cost of investigations of particular things in which they were interested, and as manifestly the regular subscribers to the Laboratories cannot be called upon to cover the expenses of tests made at the request of others, a system has been established whereby a manufacturer or owner desirous of securing an examination and report by the Laboratories on any particular device, system or material, is enabled to do so by first depositing a preliminary fee as evidence of good faith, and on completion of the work paying the balance of its cost as shown by accurate records thereof, which are kept in detail. As a warrant that an applicant will not incur costs beyond his expectations, a limit of expense is fixed in each case beyond which charges are not made. By this means an opportunity is afforded any one at comparatively low costs to secure the opinion of the recognized authorities covering any device, system or material in its relation to the fire hazard.

The amounts of the fees are in proportion to the nature and extent of the work required in examinations and tests.

The cost of experimental work is practically the same in each class of device, whether samples show superior or inferior qualities.

10. Second Fee Required for Samples Altered After Tests Commence.—These costs cover one examination and test or series of tests on one pattern or device, system, method or material only.

In case further tests on altered samples are desired, second fees must be deposited.

11. Unearned Fees Returned.—Where costs do not aggregate the amount of the preliminary fee, the balance will be returned to the applicant.

12. Form of Application.—No fixed form of application for test is required. A letter addressed to the Laboratories, setting forth all of the claims made for

the article, enclosing check, draft or money order for the amount of the preliminary fee and giving notice of shipment, is all that is necessary.

17. Attendance at Tests.—Manufacturers and owners are welcome at the Laboratories during the progress of tests upon their appliances. Advance notices of the time of making tests are not sent, however, except upon request.

22. Reports are Furnished—At the conclusion of examinations and tests, the results thereof, whether favorable or otherwise, are bulletined to the various insurance organizations and companies subscribing to or co-operating with the Laboratories' work, and a copy of this bulletin and the detailed report is furnished the applicant.

23. Recognition of Reports.—The majority of fire underwriters in the United States at the present time, and many municipal authorities, either accept or require a report from these Laboratories incident to their recognition of devices, systems and materials having a bearing upon the fire hazard, but no guarantee can be given by Underwriters' Laboratories, Inc., that its findings or the conclusions of its supervising committees will be accepted or recognized in any case. Such assurances can only be obtained from the authority having jurisdiction. Wherever approvals are granted, however, on the more common classes of devices, the names of the manufacturers thereof are placed in printed lists, distributed freely by the National Board of Fire Underwriters, and many of the leading organizations and authorities are at the present time using these lists as the basis of their recommendations or requirements.

24. Maintaining Standard of Quality in Approved Articles.—Whenever approvals of appliances are ready to issue, one of two forms of supervision over the articles to be marketed is required under such approval.

The older of these forms is a contract to be entered into between the manufacturer and Underwriters' Laboratories, Inc., whereby the maker agrees during the continuance of the Laboratories' approval to construct appliances in exact duplicate of the sample approved, and to pay certain fees annually (ranging from $5 to $25), with which the Laboratories partially defrays the costs of re-examinations made from time to time upon sample appliances secured from stocks offered for sale.

The newer form of supervision, which is considered superior by the Laboratories' management, and which is being introduced as rapidly as feasible, consists in inspections by Laboratories' engineers of devices and materials at factories and the labeling of standard goods by means of stamps, transfers or metal labels, whereby they can be recognized wherever found.

The cost of this service is partially defrayed by a small charge made for the labels. This charge is always less than 1% of the selling price of the article labeled, and consequently becomes nearly a negligible factor in determining this price. By means of this service the quality of goods in factories where approved articles are made is carefully observed, and the use of approval labels restricted to only such portion of the output as meets in all essentials the standard of efficiency shown by the sample originally tested and on which approval was based.

Experience has shown that this method is in every way superior for the purpose of bringing to the consumer the article he desires, for the purpose of placing competition between manufacturers beyond the point where deterioration in the quality of the output is made necessary, and for the proper protection of the Laboratories and the organizations co-operating with them who are giving substantial recognition to efficient fire protection appliances.

It is also shown that an inspection and checking system of this nature can be efficiently operated under the Laboratories' direction without calling upon the manufacturer to give undue publicity to his manufacturing process or subjecting him to any unhealthy annoyances.

At the present time this system is extended to upwards of 100 factories, turning out a total of about 12,000,000 labeled articles annually.

25. Branch Offices.—The extension of the factory inspection and label service has made it possible to establish branch offices of the Laboratories in many of the principal cities of the United States, thus bringing a representative near to every one in these cities who may have business with or wish to make inquiries covering the organization and its work. These offices are at present situated at the addresses given on the inside cover of this pamphlet. The engineers in charge may be freely consulted in reference to any material or appliance which has been submitted for examination.

26. Safeguard Covering Accuracy and Uniformity in the Work.—It has been the aim of the founders of this institution to have its work so conducted and reviewed as to secure accuracy and uniformity in its findings, and to this end every possible safeguard has been adopted. Its Supervising Committees are made up of many men of wide experience in the fields they are called upon to cover, all of whom are officials of insurance organizations or companies and thus have a vital interest in the integrity of the work. No approval or rating is issued until assent thereto in writing is secured from a majority of members in one of these Committees.

Examinations are conducted under detailed specifications adopted for each class of appliance, after offering opportunity to every one interested in each subject to record his views thereon.

The institution is designed to secure the best and fairest opinion regarding the merits or demerits of every device, system or material having a bearing upon the fire hazard. There can be but one such opinion, and its authoritative announcement must make for progress along right lines. Whether or not Underwriters' Laboratories, Inc., have been in a measure successful in this work can be ascertained by consultation with their clients, the insurance companies and organizations doing business in the United States, and the manufacturers and owners of over 4,000 appliances which have thus far been examined and reported upon.

W. H. MERRILL, *Manager.*

Chicago, January, 1908.

LIST OF MEMBERS ELECTED BY THE EXECUTIVE COMMITTEE SINCE LAST AUGUST.

SEPTEMBER, 1907.

ASSOCIATE.

Mr. Ferd V. Becker, Manager, Underwriters' Agency, Brookhaven, Mass.

Mr. Stanley R. Bruce, Special Agent, Western Assurance Company, Room 515, Lee Office Building, Oklahoma City, Okla.

Mr. D. A. Cummings, Insurance, Box 940, Brockville, Ontario, Canada.

Mr. A. Morton Dexter, Inspector, Factory Insurance Association, Hartford, Conn.
Mr. Malcolm B. Dutcher, Dutcher & Edmister, 58 William Street, New York, N. Y.
Mr. Chas. Gibson, Special Agent, London Assurance Corporation, 215 Kirk Building, Syracuse, N. Y.
Mr. I. Osgood, Underwriters' Bureau of New England, 36 Osgood Street, North Andover, Mass.
Mr. John H. Packard, Agency Secretary, London Assurance Corporation, 84 William Street, New York, N. Y.
Mr. L. R. Ross, Inspector, Underwriters' Bureau of Middle and Southern States, 71 William Street, New York, N. Y.
Mr. Chas. H. Smith, Engineer and Special Inspector, Associated Factory Mutual Fire Insurance Companies, 31 Milk Street, Boston, Mass.
Mr. W. H. Ticknor, Inspector, Factory Insurance Association, S. A. E. House, Worcester, Mass.

SUBSCRIBING.

Mr. James G. Beattie, Superintendent, Robert Gair Company, foot of Washington Street, Brooklyn, N. Y.
Mr. J. D. O'Keefe, Secretary, Woodward, Wight & Co., Ltd., 420 Canal Street, New Orleans, La.
Mr. A. H. Morton, Superintendent, Lowell Machine Shop, Lowell, Mass.
National Enameling & Stamping Company, Manufacturers, Box 591, New Orleans, La.
Mr. H. C. Perham, Treasurer, Lowell Machine Shop and Kitson Machine Shop, Lowell, Mass.

OCTOBER, 1907.

ASSOCIATE.

Mr. B. L. Anderson, Secretary, Manufacturers' Mutual Fire Insurance Company, 628-632 Traders Bank Building, Toronto, Ont.
Mr. Emil Anderson, Electrical Inspector, Minneapolis Underwriters' Inspection Office, 825 New York Life Building, Minneapolis, Minn.
Mr. J. A. Carruth, Inspector, The Rocky Mountain Fire Underwriters' Association, 512 Exchange Building, Denver, Col.
Mr. Geo. L. Draper, Inspector, New York Fire Insurance Exchange, 32 Nassau Street, New York.
Mr. W. J. Fenton, Manager, Atlantic Mutual Fire Insurance Association, P. O. Box 105, St. John, N. B.
Mr. Christen Moller, Daily Report Examiner, Royal Insurance Company, Ltd., 84 William Street, New York, N. Y.
Mr. I. W. Story, Inspector, Fire Underwriters' Inspection Bureau, 63 Macdonough Building, Oakland, California.
Mr. W. H. Sutton, Jr., New York Fire Insurance Exchange, 32 Nassau Street, New York.

SUBSCRIBING.

American Sheet Metal Works, Sheet Metal Workers, P. O. Box 576, New Orleans, La.
Mr. A. L. Jennings, Automatic Sprinkler Construction Company, 418 Century Building, Atlanta, Ga.
Mr. H. B. Kirkland, National Metal Moulding Company, 253 Broadway, New York, N. Y.
Mr. Frank W. Meegan, S. F. Bowser & Company, 299 Broadway, New York, N. Y.
Mr. R. G. Morrow, President, Memphis Furniture Manufacturing Company, 1146 Union Ave., Memphis, Tenn.
Mr. F. J. O'Brien, Manager Branch House Valve Department, The Fairbanks Company, Broome and LaFayette Streets, New York.

NOVEMBER, 1907.

ASSOCIATE.

Mr. James B. Campbell, Ohio Special Agent, German Fire of Indiana, Niles, Ohio.
Mr. William C. Daniel, Special Agent, Northern Assurance Company, Box 661, Columbus, Ohio.
Mr. Percy B. Dutton, New York State Manager of Humboldt of Pennsylvania and Teutonia of Pennsylvania, 403 Wilder Building, Rochester, N. Y.
Mr. Alvert H. Edgar, Inspector for Crath & Sullivan, Manhattan Building, southeast corner Fourth and Walnut Streets, Philadelphia, Pa.
Mr. John B. Kenney, Insurance Engineer, P. O. Box 422, Charleston, S. C.
Mr. Henry Charles Klein, New York Underwriters' Agency, 100 William Street, New York, N. Y.
Mr. G. R. Ladd, Thames & Batre, Insurance, Mobile, Ala.
Mr. H. O. Mourasse, Managing Director, "The Imperial Marine Transportation & Fire Insurance Company" of Tokio, 24 Harukimatchi Santcheme, Hongo, Tokio, Japan.
Mr. Walter Scott, State Agent, Home Insurance Company, N. Y., 210 American Bank Building, Kansas City, Mo.
Mr. H. K. Shaw, Rate Clerk, 131-141 South Fourth Street, Philadelphia, Pa.
Mr. Lomas Smith, Secretary Fire Underwriters' Association of Tasmania, Bank Chambers, Hobart, Tasmania.
Mr. George Ellwood Wagner, Insurance Agent and Broker, 401 Walnut Street, Philadelphia, Pa.

SUBSCRIBING.

Mr. Robert H. Foerderer, Inc., Leather Manufacturer, Frankford, Philadelphia, Pa.
Mr. P. H. Halley, Contracting Agent, General Fire Extinguishing Company, Charlotte, N. C.

Mr. Frederic C. Hood, Hood Rubber Company, 99 Bedford Street, Boston, Mass.
New Jersey Foundry & Machine Company, 9 to 15 Murray Street, New York, N. Y.
New Orleans Roofing & Metal Works, Scott, St. Louis, Toulouse and Carrollton Avenues, New Orleans, La.
Proximity Manufacturing Company, Greensboro, N. C.
Lieut. Joseph A. Webber, Aide to Chief, Boston Fire Department, Bristol Street, Boston, Mass.
Zahner Manufacturing Company, Sheet Metal Works, 316 West 20th Street, Kansas City, Mo.

Progress Reports from Committees.

EXECUTIVE COMMITTEE.

Executive Committee Meeting Held November 19, 1907. Letter read from H. O. Lacount, Engineer and Assistant Secretary, Inspection Department, Associated Factory Mutual Fire Insurance Companies, addressed to E. V. French, Chairman of Pump Committee, under date of November 16, suggesting two changes in the specifications for the construction of centrifugal fire pumps. Matter was referred to the Pump Committee with power.

Communication from L. H. Kunhardt, Chairman of Hydrant Committee, under date of November 18, detailing three (3) changes in specifications for the construction of hydrants as suggested by Mr. Lacount, and also submitting proof copy of proposed new specifications including these changes, referred to the Hydrant Committee with power.

Communication read from the Bureau for the Safe Transportation of Explosives, addressed to Mr. H. C. Henley, Chairman, under date of October 29. Secretary was instructed to reply, giving the information requested in the letter, and to also include reference to the work of the National Board of Fire Underwriters and its Committee of Consulting Engineers in the matter of Gases and Oils.

Mr. H. A. Fiske, Editor of the Quarterly, submitted verbal report in detail, giving information as to progress in his work to date. After discussion of the various points brought up, it was voted to admit advertising to the Quarterly under certain restrictions.

American Society of Mechanical Engineers.—Mr. H. A. Fiske was elected delegate to the annual meeting in December.

Society of Naval Architects and Marine Engineers.—Mr. Hugh T. Wreaks was appointed delegate to the meeting of this organization.

Hydrants and Valves.—It was voted to ask the Committee on Hydrants and Valves to prepare and submit to the Association specifications for the construction of Public Department Fire Hydrants to be used in connection with high pressure fire service.

Fire Fighting Equipment for Tug Boats.—It was voted to request Mr. R. H. Newbern to prepare a paper on this subject for presentation to the annual meeting.

Committee on Standard Hose Couplings and Hydrant Fittings for Public Fire Service.—Mr. Charles A. Hague substituted for Mr. C. H. Campbell on this Special Committee.

Special Hazard Committee—Work on Factory Standards.—The Chairman of the Committee on Special Hazards and Fire Records, Mr. Fiske, outlined proposals for work on factory standards by the appointment of sub-committees to handle each subject and report through Bulletins and to the Association at the annual meeting, this being in line with the Committee's thought at previous meeting in deciding not to re-appoint a Special Committee on the particular sub-

ject of Factory Standards. Mr. Fiske's outline for the work was endorsed.

Joint Meeting of Committees.—The Executive Committee, recognizing the advantages accruing from meetings of Special Committee on Automatic Sprinklers and Special Committee on Devices and Materials being held at the same place and during the same week as the meeting of the Executive Committee, records its views in favor of a notice being sent to the Chairmen of all Special Committees advising them that for Fall meetings the second week in November is likely to prove as convenient as any for all Committees to meet each year, and attempting by this means to make such time a fixture in Association affairs as far as Committee meetings at this season are concerned.

Illness of The President, Mr. Dudley—Suitable resolutions were adopted in reference to the illness of the President, and the Secretary was instructed to send expressions of regret of members of the Committee covering Mr. Dudley's continued illness.

W. H. MERRILL, JR., *Secretary.*

COMMITTEE ON CAR HOUSES.

After three years' work the Committee on Car Houses has finally completed its labors so far as the adoption of a standard covering construction and sprinkler protection is concerned. The new standard has just been published and is a joint recommendation adopted by both The National Fire Protection Association and American Street & Interurban Railway Association, the latter named association having adopted the new standard unanimously at its convention held in Atlantic City, N. J., during October last. By the approval of The American Street & Interurban Railway Association of this standard, an acceptance of the same might indicate that the electric railways of the country will take a special interest in the construction and protection of their properties, realizing that the rules and requirements were accepted by their own association after several conferences by a special committee with the Committee on Car Houses of the National Fire Protection Association.

The new standard deals with three types of construction of car houses, slow burning construction, protected steel and iron construction, and reinforced concrete construction. The standards recommended for these three classes are very complete, and give the builder an opportunity to select and compare in cost any one of which he may find it most convenient to construct.

The committee experienced some difficulty in harmonizing several features in the new standard relating to thicknesses of walls, size of tile blocks for fireproofing, and matters relating to reinforced concrete construction, which slightly conflicted with the National Board Building Code and Uniform Requirements, but after several conferences with other committees these features were harmonized, concessions being given in favor of car houses, due principally to the fact that the buildings are but one story in height.

The new standard asks for both aisle and ceiling sprinklers in all instances, and permits of quite a liberal area for independent sections. All in all, the new standard, it is believed, will meet with general acceptance on the part of the railway people, and underwriters will hardly consider requirements as drawn up as being too rigid for actual results.

The construction and protection subject for car houses received not only a thorough discussion at three conventions of the National Fire Protection Association, but a wide-spread interest was taken in the subject, and practical tests and demonstrations were given. It is believed, therefore, that this new standard will tend to effect in the near future improved structures of car houses, as well as making a better protected class of them.

C. H. PATTON, *Chairman.*

COMMITTEE ON DEVICES AND MATERIALS.

Meeting Held November 21 and 22, 1907.

Actions on Laboratory Reports.—Following discussions, actions were taken on a large number of Laboratory reports, and complete record will be given on printed cards to be issued covering each of the reports and appliances discussed.

Standard on Municipal Fire Alarm Apparatus.—Adopted.

Standard Requirements for the Construction and Operation of Automatic Sprinkler Alarm Valves.—Adopted with a number of amendments and additions.

Standard Requirements for the Construction of Appliances for Automatically Closing Wired Glass Windows of the Horizontally Pivoted Type.—Adopted with some amendments.

Proposition for Key Boxes in Watch Clocks.—Bulletin, August, 1907. Referred to Laboratories for conference with manufacturers and report.

Signal No. 94.—(Aero Fire Alarm.) Admitted for test.

Retardant No. 181.—(Watson's Belt Shield.) Laboratories instructed to submit suggestion for card wording without going to the trouble and expense of making test.

Pump Governors.—Laboratories requested to take up some items on this subject with Pump Committee, and Executive Committee if necessary.

W. H. MERRILL, JR., *Secretary.*

COMMITTEE ON HOSE.

This Committee is now investigating the subject of Fire Department Hose, and we hope to report definitely on a standard covering this important subject at the next meeting of the National Fire Protection Association.

Specifications to cover hose now in common use will have to embrace the following types of hose in 2½ inch, 3 inch and 3½ inch sizes.

Double-jacketed woven rubber lined hose; two and three-ply interwoven rubber lined hose; twilled double-jacketed rubber lined hose; knit double-jacketed rubber lined hose; rubber hose.

Note.—No hose having less than two jackets is being considered, since small departments which may care to use single-jacketed hose will find the approved so-called "Underwriters" hose suitable for their needs.

In gathering data from which to draft specifications, we have called upon some fifty of the larger cities for information as to types and amounts of hose in use, and for copies of specifications when these are used. The large number of comprehensive replies received indicate that the fire department chiefs take a decided interest in the subject. Specifications issued by the Government and those used by public service corporations are also being examined. We are visiting the mills of a number of the leading hose manufacturers, conferring with their practical men, and making tests of their best brands of hose. From the data obtained from these various sources, we propose to draft preliminary specifications, which will be submitted for criticism and suggestions to a number of hose manufacturers, fire chiefs, etc. The standard which will be finally submitted to the National Fire Protection Association should therefore represent the best thoughts of a large number of experienced manufacturers and users of fire department hose.

We are compiling tables of amounts of hose in use, and that purchased annually for replacement, from the information contained in replies from fire chiefs to whom we have written, and from this tabulation, it should be possible to make a fairly accurate estimate of the total amount of fire hose in use, and annual purchases in the cities of the United States.

This Committee takes pleasure in putting these facts before the members of our Association, and asks that any information which members possess, bearing on this subject, be put in its hands.

H. W. FORSTER, *Chairman.*

COMMITTEE ON PIPE.

The chairman writes as follows:

I have not accomplished anything as yet with the members of the Committee, but have gone into some preliminary work, and believe that the subject of "Pipe" can be condensed considerably by confining the Committee Report entirely to cast and wrought pipe of the styles now customary on sprinkler work.

While there are various other types of specially jointed cast-iron pipe, and spiral riveted or otherwise made up types of wrought pipe, it is quite clear that all special styles of pipe are of a lighter weight than the styles of pipe now used.

On account of the necessity for having a good body of metal to resist corrosion, and also the necessity for having a style of pipe which can be cut into at any point, to admit inserting a fitting or other form of joint for extensions or changes, it would seem to me that the Committee cannot do else than regard standard wrought and cast pipe as being the only types suitable for service, and for the basis of a Committee Report. The probability is, therefore, that the tone of the Committee Report will be to dismiss all light weight pipes, as unsuitable, and go into considerable detail respecting standard steel and iron wrought pipe, methods of jointing same, and similarly for cast-iron pipe, the latter under the specifications of the New England Water Works Association.

ALBERT BLAUVELT, *Chairman.*

COMMITTEE ON PUMPS.

1. Underwriter Steam Fire Pumps.—From time to time reports have been received from the field regarding breakage of cast metal stems of steam pump priming valves, showing conclusively that better metal should be used. Article 38 of the specifications requires that Tobin bronze be used for all valve stems, which would of course include the stems of the priming valves. However, the use of Tobin bronze at this point has not been insisted upon generally, as the earlier experience with cast metal stems was evidently quite satisfactory. In view of the recent experience it is believed that Article 38 should be carefully followed and Tobin bronze used for the stems of priming valves as well as for the main pump valves. The George F. Blake Manufacturing Company have already changed from cast bronze to Tobin bronze, and the manufacturers who may now be using the cast metal will undoubtedly also adopt the Tobin bronze as soon as their attention is called to the matter.

Pumps built in accordance with the present specifications are giving excellent results in practice, and no changes in the specifications are contemplated, in addition to those adopted at the May meeting.

2. Rotary Fire Pumps.—Several tests have been made recently on rotary pumps built according to Type A specifications and driven by electric motors. From these tests the efficiency has been found to be appreciably lower than had been anticipated, 50% to 53% efficiency being about the best thus far obtained for the pump alone. These results show the need of providing at least 30 horsepower per 250 gallons per minute discharge at 100 pounds pressure for a single gear-and-pinion drive, this being of special importance in connection with motor-driven pumps, where a considerable overloading of the prime mover might be serious, as the motor might be dangerously overheated or burned out.

Some modifications of Article 22 of the Type A specifications will undoubtedly be advisable, as in the tests the compression grease cups have not been found wholly satisfactory, requiring too much attention for the best results. It is believed that the well-known receptacle cast

with the journal cap and provided with a hinged cover is far preferable, as this permits the application of a good body of grease or oil. For the bronze bearing next the cam some form of grease cup can be used where required, and possibly for the main bearing an oil cup in addition to the grease receptacle would be advantageous.

3. Centrifugal Fire Pumps.—Interest in this style of fire pump is increasing among all parties concerned. Several manufacturers are already perfecting designs to meet the new specifications, and detail drawings have been examined and found to meet the specifications, in practically all essential features. Although but few tests of fire pumps built according to these designs have as yet been made the work thus far would seem to indicate that it is entirely feasible to make a satisfactory fire pump along the lines of the specifications.

The question of permitting higher speeds than mentioned in the specifications has been raised by certain designers, the advantage claimed being larger capacity for a given size and a somewhat simpler construction of pump. It may be that for certain types the present requirements as to speed may need some modification, but it is believed that, at least for the present and until much more data is available to show that it is entirely safe to permit as high speeds as now used in generator and motor practice, the speeds of centrifugal fire pumps should be kept within some reasonable limits, which would seem to be approximately as given in the specifications.

E. V. FRENCH, *Chairman.*

COMMITTEE ON ROOFS AND ROOFINGS.

The chairman writes as follows:

I propose to send a copy of the specifications as submitted to the last annual meeting of the National Fire Protection Association to each Rating Association and Inspection Bureau in the United States and Canada, hoping thereby to receive such criticisms as will be advantageous to the Committee. The Chairman of the Committee is also open to any suggestions that may be offered by any member of the National Fire Protection Association. I would suggest, however, where criticisms are made, that suggestions for the improvement of this report be submitted along with such criticisms.

A. P. STRADLING, *Chairman.*

COMMITTEE ON SPECIAL HAZARDS AND FIRE RECORD.

The Editor has already called attention to the fact that an index has been published covering the Quarterly Bulletins Nos. 1 to 17. This index should prove of considerable value to members.

At the last meeting of the Executive Committee it was suggested that the Commitee on Special Hazards and Fire Record continue the

work of the Factory Standard Committee somewhat along the following lines. That sub-committees be appointed on the various classes of occupancy and that these sub-committees prepare articles or papers covering the various features of construction, protection and hazards and present them to the Association either through the Quarterly or at the Annual Meeting. Such articles could be accepted by the Association, as giving the best information at our command, printed and distributed as desired, this without any attempt to provide rules or a standard, which latter we have found to be most difficult if not impracticable. There is certainly a demand on the part of the manufacturers for information as to the best way to build and protect their plants and it seems desirable for our Association to be in a position to furnish this information.

It would seem that the sub-committee could use as a basis of their report some of the articles or papers already published by the Association, many of which cover the processes and hazards in a very complete manner. The Committee feel that it is quite feasible to work out this subject along the lines indicated and will endeavor to make some headway before the next Annual Meeting although a lack of time on the part of most of our active members makes it difficult to prepare subject matter of this nature on short notice.

HENRY A. FISKE, *Chairman.*

COMMITTEE ON STANDARD HOSE COUPLINGS AND HYDRANT FITTINGS FOR PUBLIC FIRE SERVICE.

As will be seen under the report of the Executive Committee the membership of this Committee has been changed by the substitution of Mr. Charles A. Hague, the present representative of the American Water Works Association, in place of Mr. C. H. Campbell, the former representative of that Association.

F. M. GRISWOLD, *Chairman.*

COMMITTEE ON FIRE-PROOF CONSTRUCTION.

Attention is again called, by the Committee on Fire-proof Construction, to the fire report blanks recently issued and commented on in the last number of the Quarterly.

Thus far, only a few of these blanks have been returned, though the Committee feels that members must be aware of a good many fires of recent date which would furnish interesting information by means of these reports.

It is hoped that members will make free use of these blanks in order that as extensive a record as possible may be obtained and this publication provided with interesting matter on the subject.

E. T. CAIRNS, *Chairman.*

Metal Workers---Fire Record.

This record includes all of the ordinary metal workers some of which may be enumerated as follows: Beds (Metal), Boiler Works, Bolt and Nut Manufacturing, Cotton Machinery, Cutlery and Hardware, Engine Works, File Works, Gun Works, Jewelry Factories, Metal Lamps and Lanterns, Nail Factories, Pin Factories, Rivet Manufacturing, Rolling and Wire Mills, Saw Works, Soda Fountain Manufacturing, Silverware Manufacturing, Stamping and Sheet Metal Workers, Miscellaneous Metal Workers.

It does not include foundries or casting shops even when part of the metal working plant, these risks have been reported upon separately in the Special Hazard Bulletin. It does not include the mixed metal and wood workers such as Agricultural Implements, nor does it include the largely increasing class of Automobile Factories.

An attempt was made to divide the metal workers into several subclasses such as Machine Shops, Rolling Mills, Sheet Metal Workers, Jewelry Factories, etc., but it was found to be a difficult matter and, as many of the hazards are common to all and the number of fires too small to make it desirable to divide into separate parts, it was taken up as a whole. The relative importance of the various hazards will of course vary according to the particular class of occupancy and it may be feasible to later on divide into subclasses so as to more definitely bring out this feature.

Total Number of Fires, 818.

1. CLASSIFICATION OF CAUSES.

Common Causes.

LIGHTING. Number of fires, 33.
- Electric (Arc or Incandescent), 14 fires.
  - Electric arc light generator flashed over and grounded.
  - Crossed electric light wires, 2 fires.
  - Defective electric light wiring, 2 fires.
  - Incandescent electric light left lying on top of pile of box lumber.
  - Incandescent electric light laid on celluloid keys of adding machine.
  - Employee broke incandescent light in rubbish igniting same.
  - Incandescent electric light ignited overalls.
  - Defective resistance box for electric lights.
  - Short circuit of electric light socket.
  - Incandescent electric light short circuited.
  - Sparks from dynamo, 2 fires.
- Gas lighting, 5 fires.
  - Lava tip blew out of gas jet.
  - Gas jet ignited curtains.
  - Gas jet against shelf.
  - Defective gas fixture.
  - Caused by open gas jet.
- Kerosene oil lamps, 2 fires.

Open oil lamp ignited lint and dust in beltway.
Open oil lamp ignited lint in basement of engine room.
Kerosene oil watchman's lantern, 5 fires.
Watchman's lantern knocked on floor.
Watchman careless in handling lantern.
Watchman's lantern ignited oil.
Overturned watchman's lantern.
Watchman's lantern.
Kerosene oil torches, 4 fires.
Workman's torch ignited roof.
Waste ignited by open torch.
Open light ignited dust in blower pipe which men were painting.
Open kerosene torch.
Candles, 3 fires.
Carelessness of employee repairing belt and using candle for light.
Employee ignited paper with lighted taper.
Candle ignited oil on shafting.

HEATING. Number of fires, 16.
Steam heating, 3 fires.
Refuse on coils of steam heating pipes.
Steam-pipe in contact with woodwork.
Steam-pipe ignited wooden partition.
Hot air heating, 2 fires.
Caused by hot air heating and ventilating system.
From hot air heater.
Hot water heating, 1 fire.
Defective flue from hot water heater in basement.
Stove heating, 9 fires.
Overheated stoves, 3 fires.
Overheated stove ignited dust and oil on pipes overhead.
Stove ignited paper patterns.
Metal flue ignited woodwork being too near ceiling.
Defective flue ignited woodwork on upper floor.
Defective chimney became overheated.
Oil stove for heating.
Overheating of flue from coke salamander used to assist in drying out of several concrete bases for machines.

POWER. Number of fires, 34.
Shafting, pulleys and bearings, 19 fires.
Overheated bearings, 6 fires.
Hot bearing on shaft of heat fan.
Hot box at ventilating fan.
Hot bearing on counter shaft.
Hot box at bearing to tumbling barrel ignited sawdust.
Hot bearing on dust collector.
Hot bearing ignited grease and oil.
Spark from heated journal ignited belt.
Hot bearing at dynamo.
Caused from broken shaft.
Friction at shaft.

Spark from loose pulley ignited sawdust.
Friction at wooden pulley.
Loose pulley on jack shaft became overheated igniting dust and oil.
Steam engine, 2 fires.
Heated journal on engine.
Overheated post close to exhaust pipe from steam engine.
Gas engine, 6 fires.
Caused by escaping producer gas.
Unknown at gas producer.
Started from connection to gas engine under floor.
Leak at supply pipe to gas engine.
Gas pressure being low caused the engine to explode often which heated exhaust and ignited woodwork.
Barrel used to muffle exhaust from gas producer engine became ignited.
Electric power, 7 fires.
Spark from power motor ignited woodwork.
Electric motor burned out.
Sparks from electric motor encased in wooden box on ceiling.
Sparks from elevator motor ignited sawdust used for absorbing oil temporarily.
Heavy current over wires to motor.
Heavy current burned out wooden switchboard.
Defective electric wiring at motor.

BOILER (or fuel). Number of fires, 49.
Spontaneous combustion of soft coal, 5 fires.
Overheated woodwork, 12 fires.
Heat from boiler ignited woodwork, 3 fires.
Heat from flue ignited woodwork.
Heat from metal boiler stack ignited woodwork of second floor.
Stack ignited woodwork.
Heat from boilers ignited roof joists.
Overheated boiler ignited roof.
Heat from boilers ignited combustible material.
Overheated boiler breeching.
Combustible material against flue.
Started under floor near boiler
Sparks from boiler, 14 fires.
Sparks from boiler, 5 fires.
Sparks from boiler lodged in shavings, 2 fires.
Sparks from boiler in shaving bin.
Sparks from boiler to fuel room.
Sparks from boiler ignited dust on frame partition.
Sparks from boiler ignited woodwork.
Sparks from boiler in pile of kindlings.
Caused from defective boiler setting.
Defective boiler setting allowed sparks to get into refuse near same.
Combustible material on top of boiler, 4 fires.
Lumber on top of boiler.
Ignition of rubbish on boiler top.

Heat ignited dirt and rubbish on boiler.
Belt broke and fell on top of boiler.
Sparks from stack, 4 fires.
Hot ashes, 5 fires.
Hot ashes, 3 fires.
Waste paper placed on hot ashes.
Hot ashes ignited oil.
Occurred in barrel of kindling wood.
Fuel oil pipe became clogged in repairing same, oil overflowed and ignited.
Employee started fire and left, the automatic fuel feed caused fire.
Boiler explosion, 2 fires.

RUBBISH (or sweepings). Number of fires, 30.
Spontaneous combustion of rubbish, 23 fires.
Spontaneous combustion of sweepings, 5 fires.
Spontaneous combustion in barrel of iron filings, sweepings and sawdust.
Spontaneous combustion in barrel of shavings.

OILY MATERIAL. Number of fires, 72.
Spontaneous combustion of oily waste, 44 fires.
Spontaneous combustion of oily material, 20 fires.
Spontaneous combustion of oily clothes, 8 fires.

SMOKING. Number of fires, 18.
Employee smoking, 14 fires.
Started in cuspidor, 2 fires.
Cigar or cigarette thrown in pile of charcoal bags.
Cigarette or match thrown into paper refuse.

LIGHTNING. Number of fires, 12.

LOCOMOTIVE SPARKS. Number of fires, 19.

MISCELLANEOUS. Number of fires, 22.
Matches in clothing, 4 fires.
Match dropped into boxed stock.
Employee with match ignited woodwork of nitric acid cabinet which had become porous.
Lighted match ignited oil.
Match ignited pot of paint.
Spontaneous combustion in dust collected on beam.
Spontaneous combustion in bale of clean waste.
Spontaneous combustion of printing or marking rolls.
Burning waste and sweepings in waste furnace.
Hot embers from fire on third floor dropped into old fireplace on first floor. Fireplace was boarded up and woodwork ignited.
High voltage wire crossing telephone wire.
Short circuit of telephone wire with trolley wire on street.
Cable of derrick on adjoining building crossed trolley wire and short circuit burned hole in gas main in basement.
Spark or friction at ventilating fan, 2 fires.
Repairing gas-pipe gas ignited.
Gas filter exploded, (producer gas).

Ignition of benzine vapors inside of boiler under repairs.
Canvas covering on steam-pipes ignited.

Special Hazard Causes.

STORAGE OF OILS. Number of fires, 1.
Man went into oil room with lighted lantern and ignited oil.

STORAGE OF ACIDS. Number of fires, 4.
Probably acid in straw of one of the carboys ignited same.
Nitric acid spilled on packing material.
Broken carboy of nitric acid.
Leaking of nitric acid.

ACID DIPPING. Number of fires, 3.
Man examining wooden hood over acid dipping pot ignited same with candle or match used for light.
Originated in hood over dip tank where fumes from muriatic, sulphuric and nitric acids are carried to outside chute.
Electric light hung over kettle of nitric acid, insulation was destroyed and bare wires ignited woodwork.

STEEL CHIPS AND OIL. Number of fires, 3.
Spontaneous combustion in oily metal chips, 2 fires.
Spontaneous combustion of steel chips and oil in drip can.

FORGES, (including drop forge or hammer). Number of fires, 22.
Sparks from forges, 13.
Sparks from forge, 6 fires.
Sparks from forge ignited floor under wooden bench.
Sparks from forge in oil-soaked woodwork.
Sparks from forge lodged in joists of ceiling.
Sparks from forge worked through crack in floor to ceiling below, starting fire.
Sparks from forge ignited dust in pipe.
Sparks flying into belt pit which was oily.
Sparks from forge set fire in charcoal standing near by.
Sparks from drop forge or hammer, 3 fires.
Sparks from drop forge ignited waste.
Sparks from drop forge ignited oil and grease on bearing.
Sparks from drop forge.
Stack from forge ignited roof.
Heat from a small forge.
Hot ashes from forge placed in defective iron can ignited ceiling of second floor.
Accumulation of gas in forge blower pipe ignited by open light.
Employee cleaning wax and rosin from copper placed same in forge to soften, rosin melted and ignited from forge.
Caused from blacksmith forge.

HOT METAL IGNITING COMBUSTIBLE MATERIAL. Number of fires, 5.
Red-hot irons were placed near iron-covered partition igniting wood in back of same.
Hot plate on wooden floor.

Hot ball thrown by employee into pile of wire with gummy sack covering.
Hot rivet thrown into old clothes.
Spark from hot wire.

FUEL OIL. (For heating furnaces.) Number of fires, 11.
Fuel oil at furnace, 5 fires.
Oil for firing furnace escaped and ignited.
Explosion of crude oil under tempering furnace.
Oil pipe became broken at elbow joint into furnace.
Fuel oil pipe breaking at heating furnace.
Fuel oil under tinning furnace.
Fuel oil at pump, 2 fires.
Open torch ignited oil at fuel oil pump.
Unknown at fuel oil pump.
Fuel oil pipe leaked and oil ignited.
Oil hose blew off at coupling and oil ignited.
Breaking of fuel oil pipe.
Spark from drill ignited fuel oil tank.

MUFFLERS, ANNEALING AND HARDENING FURNACES, ETC. Number of fires, 46.
Annealing furnaces, 8 fires.
Sparks from annealing furnaces, 2 fires.
Overheated woodwork, 4 fires.
Superheated air from annealing ovens burst into flames when doors were opened.
Barrel of charcoal ignited from heat of annealing furnace.
Hardening and blueing furnaces, 8 fires.
Overheated woodwork, 4 fires.
Heat from iron flue of blueing furnace.
Heat from tempering furnace.
Heat from chimney of case-hardening furnace ignited woodwork back of chimney.
Hardening furnace ignited woodwork.
Bottom burned out of kettle of saltpetre and black oxide of manganese allowing same to spread on floor.
Overheating of chip bone used for case-hardening, ignited receptacle.
Defective flue from case-hardening furnace.
Hot ashes from hardening furnace.
Mufflers, 6 fires.
Overheated woodwork, 2 fires.
Defective furnace flue.
Plate over muffler set fire to woodwork.
Heat from flue of muffler ignited coal.
Leaky oil burner at muffler.
Sparks from muffler.
Coals from muffler.
Furnaces, 24 fires.
Overheated woodwork, 13 fires.
Wood on top of furnace.
Heat from riveting furnace.

Heat from fuel oil furnace, 2 fires.
Heat from brass furnace.
Stack from furnace ignited roof, 3 fires.
Flames from broken flue ignited roof.
Caught from heating furnace stack in which lining had worn out.
Defective flue at copper refining furnace.
Defective flue at puddling furnace.
Furnace ignited combustible material.
Sparks from furnace, 7 fires.
Sparks from furnace, 2 fires.
Sparks from furnace ignited roof.
Sparks from welding furnace.
Sparks from melting furnace.
Sparks from furnace ignited oil-soaked woodwork.
Sparks from melting furnace set fire to pile of wood used as fuel.
Flame from oven heated by crude oil.
Flash from furnace.
Dust on top of heating furnace ignited by explosion of coal gas.
Coals from furnace.

ENAMELLING FURNACES. (Sheet metal.) Number of fires, 2.
Brick enamelling furnace ignited scantlings resting on one corner.
Fire started near chimney from enamel kilns.

ROLLING MILL. Number of fires, 3.
Spark from squeezer lodged in storeroom.
Spark from rolling mill ignited oil in wheel pit.
Spark from rolling mill.

TINNING FURNACE. (Galvanizing.) Number of fires, 7.
Heat from tinning furnace ignited flooring, 4 fires.
Tinning pan ignited floor.
Tinners' furnace ignited wood floor and timbers below.
Heat from tinning furnace ignited wood platform.
Heat from galvanizing furnace ignited floor.
Collection of grease in ventilating flue over tinning furnace ignited.
Breaking of burner on gasolene tinning furnace.
Caused by tinning furnace.

BRAZING. Number of fires, 1.
Spark from charcoal used for brazing.

SOLDERING. Number of fires, 9.
Gas soldering furnace ignited waste.
Gas soldering stove ignited wooden bench due to improper installation.
Leaky tinner's torch allowed gasolene to rise to flame above.
Gasolene tinner's pot ignited.
Explosion of gasolene from cause unknown.
Soldering pot ignited wooden bench.
Ashes from soldering iron heaters placed in wooden box, box ignited.
Plumbers' gasolene furnace ignited.
Employee tried to solder a large can with gasolene still in it. Can exploded and threw gasolene over the floor.

OIL TEMPERING. Number of fires, 14.
Overheating of oil, 9 fires.

Overheating of oil in tempering.
Oil in tempering tank taking fire.
Oil in tempering tank flashed from overheating.
Ignition of oil tempering bath in blacksmith shop.
Employee left building without shutting off crude oil, allowing oil baths to become overheated.
Oil for tempering in small metal tanks ignited; supposed to have been heated up to the ignition point.
Overheated fish oil ignited.
Overheating of oil for hardening.
Overheating of pot of hardening oil by gas burner.
Springs heated red-hot and dipped into tank of fish oil, oil ignited.
Boy dipping hot shells into oil, oil ignited in some way.
Ember from fire blew into tank of whale oil used to harden saws.
Hardening pot too near wood partition.
Caused by oil tempering.

PAINTING AND VARNISHING. Number of fires, 4.
Heating of tar paint on stove.
Man varnishing currycombs lighted a lamp and vapor from varnish ignited.
Spontaneous combustion of finishing rags.
Originated in paint room.

JAPAN DIP TANK. (Including paint dipping.) Number of fires, 20
Electric light fuse blew out over japan tank.
Boy lighting gas over dip tank dropped match into tank.
Employee lowered lantern into dip tank to ascertain quantity of material, lantern ignited vapor.
Employee struck match at dip tank.
Employee stepped upon match, head flew into dip tank igniting same, 2 fires.
Ignition of mixture in japan tank by match.
Careless use of a lighted candle set fire to asphaltum varnish in small iron dip tank.
Watchman's lantern ignited paint dip tank.
Spark from drop forge ignited japan in small dip tank.
Spark from foundry blew through window and fell into dip tank.
Employee scraping off drip racks with hot shovel when flash occurred.
Carelessness in cleaning dip tank and drain board.
Occurred on japan dipping table.
Ignition of gasolene vapors from asphlatum dip tank.
Boy lighted match and threw at workman who was dipping pieces of sheet metal in dip tank.
Started in dip tank containing a mixture of asphaltum and benzine.
Japan dip tank ignited, 3 fires.

JAPAN OVENS. Number of fires, 26.
Heat from japan oven ignites combustible material, 8 fires.
Overheated oven charred flooring.
Woodwork against japan oven, 2 fires.
Heat from japan oven ignited woodwork.
Heat from japan oven.

Overheated gas-heated japan oven.
Radiation from gas flame ignited floor boards.
Overheated japan oven.
Ignition of inflammable vapors, 6 fires.
Explosion of gasolene in japan oven.
Explosion of japan oven.
Accumulation of gas due to poor draft, explosion.
Accumulated gases from japan oven.
Accumulation of gases in heated oven after fire was extinguished caused an explosion. Flue did not carry off gas fast enough.
Vapor from drying varnish ignited by open gas jet when door was opened.
Overheated flue from japan oven.
Spark from japan oven flue.
Smoke-pipe from japan oven.
Combustion in oil drying furnace.
Employee lighting japanning oven ignited japan spilled on floor.
In contents of japan oven.
Caused from japan ovens, 6 fires.

JAPANNING. Number of fires, 11.
Claim spilled japan on floor during the day.
Benzine paint ignited by sparks from cold metal saw.
Ignition of benzine vapor.
Explosion of naphtha in japanning room.
Ignition of black dip in a metal can.
Vapor from asphaltum ignited.
Lamp ignited asphaltum varnish.
Employee in lighting gas jet in japanning room dropped match either in japan spilled on floor or into dip tank.
Carelessness of boy carrying torch.
Small boy dropped match into pail of japan which he had drawn.
Carelessness with matches in presence of asphaltum paint.

LACQUER DIP TANK. Number of fires, 3.
Workman doing dipping with lacquer used open torch which ignited fumes from lacquer.
Boy struck match to see work over dip tank.
Static electricity from large belt was conveyed through steel rod to lacquer dip tank igniting same.

LACQUER OVENS. Number of fires, 7.
Electricity from trolley current ignited gas from lacquer goods in dry box.
Ignition of lacquer vapor from open gas light used to heat oven.
Steam-heated lacquer oven, vapor ignited.
Overheated lacquer drying oven.
Steam-heated lacquer oven.
Occurred in lacquer dry box, 2 fires.

LACQUERING. Number of fires, 2.
Upsetting pot of lacquer used on curtain pole trimmings.
Employee used lighted candle to see when putting work into oven as

electric lights were out of service, candle fell into basket of freshly dipped articles.

BUFFING AND POLISHING. Number of fires, 29.

Caused from buffing dust, 18 fires.

Spontaneous combustion of buffing dust, 7 fires.

Spontaneous combustion of buffing dust or spark from wheel.

Spark or spontaneous combustion of buffings in iron waste box on roof.

Spontaneous combustion in barrel of buffing dust, 2 fires.

Spontaneous combustion in barrel of sweepings from buffing room.

Spontaneous combustion in barrel of buffing dust and oily material.

Spontaneous combustion in emery dust.

Buffing dust fires, 3.

Spontaneous combustion of cotton fibre from buffing wheel.

Sparks from buffing and polishing, 8 fires.

Sparks from polishing wheel ignited dust.

Sparks from sanding machine ignited dust.

Spark in fan of blower system from buffers.

Ignition of dust and lint on floor from buffing wheel.

Sparks from emery wheel, 3 fires.

Spark ignited buffing dust.

Started in blower at polishing machine.

Spontaneous combustion of vienna lime and leather dust used for polishing.

Caused by the pipe of sand blast becoming heated, which caused explosion.

GAS BURNERS FOR BENCH WORK. (Jewelers, Etc.) Number of fires, 4.

Gas stove on bench.

Caused by gas burner on small enameling bench.

Bunsen burner ignited overalls.

Rubber tube slipped off gas stove.

BENZINE AND GASOLENE. (Cleaning, Etc.) Number of fires, 15.

Benzine cleaning rags ignited.

Benzine vapors ignited from spark from electric motor.

Benzine thrown into water closet ignited.

Benzine caught fire while being used to clean heavy steel bar.

Benzine igniting when being drawn from barrel.

Match ignited can of benzine.

Match ignited benzine.

Man scratched match on jar of benzine.

Workman stepped on match and caused fire in benzine dip tank.

Gasolene vapors ignited by electric spark.

Gasolene ignited by employee.

Employee using gasolene for cleaning purposes ignited same with pipe.

Naphtha used for cleaning was ignited when gas jet near by was lighted.

Employee washed his hands in pail of naphtha with candle for light.

Ignition of naphtha vapor in can of waste by watchman's lantern.

GLUE POTS. Number of fires, 2.
Kerosene oil glue heater caught fire and employee failing to throw it out of window dropped it into tank of water. Burning oil floated on water igniting frame partition.
Caused by upsetting glue pot heated by a kerosene oil lamp on bench.
SAWDUST. (For cleaning, drying or oil.) Number of fires, 5.
Spontaneous combustion of sawdust from tumbler for metal parts.
Fire started in bin where pine sawdust was used for cleaning purposes.
Spontaneous combustion in sawdust.
Spontaneous combustion in bin of sawdust.
Spontaneous combustion of moist sawdust.
DRY KILN. (Lumber.) Number of fires, 10.
Overheated dry kiln.
Drying tube from room below.
Combustible refuse collecting on steam pipes.
Steam pipes ignited wood in dry kiln.
Lumber on steam pipes in dry kiln.
Steam-heated dry kiln.
Stove-heated lumber dry kiln.
Unknown in dry kiln, 3 fires.
MISCELLANEOUS. Number of fires, 27.
Celluloid working, (jewelry, etc.), 3 fires.
Gas light swung into 300 celluloid combs.
Sparks from saw ignited celluloid dust on saw table. Celluloid had been sawed up in the morning and waste was not taken care of.
Spontaneous combustion of celluloid.
Spontaneous combustion of charcoal dust, 3 fires.
Spontaneous combustion of chemicals.
Gasolene ignited while testing stoves.
Ether ignited from gas flame.
Alcohol lamp exploded.
Barrel of pitch ignited.
Dropped burning pitch into benzine.
Caused by ironing pitch used for filling cracks in plating vats.
Experimental gas-heated oven.
Gas-heated wax kettle boiled over.
Gas stove left burning under a kettle of soap, water and lard oil mixture; water evaporated and oil ignited.
Overheating of gas stove used for expelling moisture from calcium chloride.
Started near a small gas bench stove used to heat sulphur compounds.
Pail with mixture of oil and naphtha accumulated on outside was filled with water and placed over gas for heating; mixture ignited.
Employee placed ignited piece of charcoal in drawer.
Pot of rosin heated in forge for bending pipe was ignited.
Waste which was being dried ignited.
Shaving collector clogged.
Friction of gears of wire drawing machine.
Friction at circular saw.
Hot cinders on floor.
Overturning of kerosene oil lamp used for annealing.

Summary.

Common Causes.

		No. of Fires.	Per Cent. of Whole.
Lighting		33	5.4
Electric (Arc or Incandescent)	14		
Gas	5		
Kerosene Oil Lamps	2		
Kerosene Oil Watchman's Lantern	5		
Kerosene Oil Torch	4		
Candles	3		
Heating		16	2.6
Steam	3		
Hot Air	2		
Hot Water	1		
Stoves	10		
Power		34	5.6
Shafting, Pulleys and Bearings	19		
Steam Engine	2		
Gas Engine	6		
Electric	7		
Boiler (or fuel)		49	8.1
Overheated Woodwork	12		
Sparks from Boiler	14		
Combustible Material on Top of Boiler	4		
Sparks from Stack	4		
Spontaneous Combustion of Soft Coal	5		
Hot Ashes	5		
Miscellaneous	5		
Rubbish (or sweepings)		30	4.9
Oily Material		72	11.9
Spontaneous Combustion of Oily Waste	44		
Spontaneous Combustion of Oily Material	20		
Spontaneous Combustion of Oily Clothes	8		
Smoking		18	2.9
Lightning		12	1.9
Locomotive Sparks		19	3.1
Miscellaneous		22	3.6
Total		305	

Special Hazards.

Storage of Oils		1	.1
Storage of Acids		4	.6
Acid Dipping		3	.5
Steel Chips and Oil		3	.5
Forges (including drop forge or hammer)		22	3.7

	No. of Fires.	Per Cent. of Whole.
Hot Metal (igniting combustible material)	5	.8
Fuel Oil (for heating furnaces)	11	1.8
Mufflers, Annealing and Hardening Furnaces, Etc.	46	7.6
Enameling Furnaces	2	.3
Rolling Mills	3	.5
Tinning Furnaces	7	1.1
Brazing	1	.1
Soldering	9	1.5
Oil Tempering	14	2.3
Painting and Varnishing	4	.6
Japan Dip Tanks (including paint dipping)	20	3.3
Japan Ovens	26	4.3
Japanning (other than above)	11	1.8
Lacquer Dip Tanks	3	.5
Lacquer Ovens	7	1.1
Lacquering (other than above)	2	.3
Buffing (and polishing)	29	4.8
Gas Burners for Bench Work	4	.6
Benzine and Gasolene, (cleaning, etc.)	15	2.5
Glue Pots	2	.3
Sawdust (for cleaning, drying, etc.)	5	.8
Dry Kilns (lumber)	10	1.4
Miscellaneous	27	4.5
Total	296	
Common Causes	305	51.
Special Hazards	296	49.
Total	601	
Incendiary	12	
Exposure	19	
Cause Unknown Fires	186	
Total Metal Worker Fires	818	

2. DETAIL OF CAUSES.

Common Causes.

H-670. Fire causes from a blower ventilating system consisting of a ventilating fan in wall in basement adjoining engine room. The fan is used to draw the heat from engine and boiler room. Connecting with the fan is a galvanized iron flue which extends up and through the different floors for heating purposes. Connecting with this flue in the engine room is another flue which runs to ash pit under grate of boiler for artificial draft.

The cause of the fire was due to the fact that the engineer after banking the fire for the night carelessly left the draft damper open, the damper in boiler flue proper was left closed, this reversed the draft and the fire was forced through the grate and ash pit into the 14-

inch draft pipe leading to the blower which became overheated and set fire to the woodwork overhead.

S-830. Employee was working around shafting with candle and set fire to drip pan under bearing which was filled with waste to catch oil from bearing.

M-11-23-03. Fire occurred at 12.10 p. m. in the engine room of the main mill. Just after the mill had shut down for the noon hour while the men were measuring for a new main belt to replace the present 24-inch belt they accidentally let the tape they were using fall into the wheel pit under the fly-wheel. As a man reached for this tape the open oil lamp which he held came in contact with the lint adhering to the sides of the pit igniting same. The fire flashed over the pit and up the sides of the partition into the flooring above.

Special Hazards.

S-1267. Bottom of kettle used to melt saltpetre and black oxide of manganese burned out allowing contents to spread on floor. This compound is used for case hardening and blueing, and is heated to such a temperature that it will ignite wood before it is suitable to use. These kettles occasionally burn out, but when they are in a weak condition the bottom bulges and they are condemned. The kettle that burned out was examined in the morning and showed no signs of weakness.

S-5200. Springs are heated to red heat in gas furnace and dipped in a hooded tank of fish oil having smoke pipe to brick stack. Oil was ignited and employee left door on hood open the flash opening a sprinkler.

S-3025. Fire was caused by the carelessness of an employee hanging an electric incandescent lamp cord over a kettle of nitric acid in acid room, cord to lamp being cut through to bare wire which caused an arc setting fire to woodwork. Flames extended through chute to outside of building.

S-2524. Steam left turned on by accident in japan tank caused evaporation of benzine which drifted through open door past nail blueing machine. Latter burns oil fuel and flame ignited vapors.

M-7-19-91. Fire occurred during the day in the tinning room originating in connection with the use of petroleum for keeping tin melted in the furnaces. The plug cock broke on the outside, the oil could not be turned off and it flooded the furnace when the steam jet was shut off.

M-2-11-93. Fire occurred in the japanning room at 5.45 p. m. In this room there was a cask of reducing spirits consisting largely of benzine and under the faucet of the cask was a pail where the operators washed their hands using the material to remove paint and japan. At the time of fire the room was being cleaned up for the night and a person wishing more light attempted to light a gas jet. As he scratched the match the lighted end broke off and went into the pail. He immediately carried the burning pail out of doors and in doing so spilled some of the contents on the floor. The flames spread and the barrel exploded blowing out the windows. The water which was

put on the fire seemed only to float it about, but it was finally extinguished by hose streams from hydrants without communicating to the other buildings.

M-7-10-01. At 2 p. m. fire occurred in a japan oven probably caused by something combustible getting into the air blast which being ignited in the combustion chamber carried fire into the oven itself. When fire was discovered the foreman had the gas shut off and sealed up the door as tightly as possible and left the damper open for fear of an explosion if it should be closed. The fire gradually consumed the japan from the goods in the oven and heated them to such an extent as to destroy the temper in them so that they are a total loss. There was also some damage to the oven.

M-10-24-02. Fire occurred in the boiler shop between 3 and 4 p. m. The hose that was filling a rivet heater heated with oil blew off from the coupling and the stream of oil that issued caught fire from another coke rivet heater.

M-7-11-03. Fire occurred in barrel department of rifle factory caused by spontaneous combustion. Watchman smelled burning oil and on investigating found a draining drip can which was half full of steel chips and contained oil, half lard and half mineral, smoldering and smoking.

M-8-31-03. Fire occurred in japan building at 11.30 a. m. This building contained three japan ovens all heated by gasolene gas. The largest oven has two burners one of which became extinguished and gas was shut off from this burner but not from the other. Before the valve was closed a small quantity of gas had collected and when door of oven was opened this gas was ignited by inrush of air and the japan on the goods and racks of the oven took fire. The gas was immediately shut off inside and outside of the building when the fire burned itself out in about twenty minutes, no water being used.

M-12-23-03. At 10 a. m. a fire occurred in the lacquer room on the top floor of building No. 5. The middle kiln of the three in the room had been emptied of work and a man was beginning to refill the same. As he entered the oven with racks of work, he saw fire flash up from the floor near the steam valve connected with the heating coil in the bottom of the oven. The workman quickly escaped from the oven and claims to have pushed the door as he ran from the place. A sprinkler inside the kiln opened, but the fire spread to two lacquer tanks in front of the oven, and nine sprinklers in the room opened. The fire door cutting off this room was closed and the fire was extinguished with two large hose streams, two chemical fire extinguishers and the sprinklers. The cause of the fire is unknown.

M-9-13-04. At 3.30 p. m. fire was discovered in the lacquer room on the third floor. It orginated in the dryer and was caused by the lacquer dripping from the stock upon the steam pipes and taking fire. A sprinkler located in the dryer opened and the water from same displaced the burning lacquer in the dip tank and caused it to float over the floor.

Eight additional sprinklers in the room opened and prevented further damage, the fire being confined to the lacquer room itself. The water leaked through both floors below.

This fire illustrates the need of having well-arranged automatic-closing covers on all dip tanks.

M-12-29-06. At 4.15 p. m. a fire occurred in the second story of building in which the material for knife handles, such as bone, ivory, pearl, pyroline, etc., is sawed up. This fire, while not a serious one, illustrates the danger attending the use of celluloid or similar products. Pyroline is used in cutlery works as a material for making handles for knives, forks, etc. The material comes in sheets about half an inch thick and is then sawed up into pieces of a size for working the handles. Some of this material had been sawed up on the dry saw on the morning of the day of the explosion. The waste had been cleaned up and in the afternoon a man was engaged in splitting some brass ferrules at the same saw. He states that a spark flew from his saw, set fire to dust on walls; a quick flash of fire came, followed by a loud report like an explosion. The man working at the saw was the only man in the room. He was badly burned on face and arm and was thrown about six feet from the saw. He immediately recovered himself and turned on the water from a small hose which was available in the room and had the fire practically under control when six automatic sprinklers operated. The explosion blew out eight window sashes in the room. In the future it is understood that this material will all be sawed by the wet process which would prevent any accumulation of dust in the room.

M-4-24-07. Fire occurred in forge room at 8 a. m. Part of the heating of the steel is done in crude oil furnaces, the crude oil being pumped to the burner and the fire is blown into the oven. It is customary after the burner is lighted for the blaze to come out through the opening in the oven, but at this time an unusual amount of fire issued from the oven and ignited the woodwork over the hood. The fire spread rapidly into the roof damaging the roof and monitor. Seven hose streams were used and fire extinguished in about an hour. A galvanized iron funnel extending through the roof is to be put in at each furnace to carry off the blaze.

M-10-31-04. A fire started in blacksmith shop at 7.45 a. m., caused by a spark from an open torch which the foreman was using while repairing oil fuel pump in pit. The spark fell into the tank used for catching leakage from the pump, which contained four or five inches of oil. Three sprinklers at the roof opened and with the assistance of hose streams and dry chemical extinguishers the fire was confined to the space around the pump.

M-1-6-05. Fire occurred in wire mill at 8.30 a. m. caused by wheel of truck striking vertical fuel oil pipe, breaking it off. The oil flowed over the iron floor and was ignited by the furnace fire.

M-3-12-06. In the summer of 1905 a large vacant space adjoining the old pattern shop, now occupied as a storehouse for cans, had been covered by a frame building. The work carried on in this building is the manufacturing of galvanized iron tanks for use in artificial ice machines, also the general plumbing business of the establishment was carried on there. It appears that gasolene plumbers' furnaces and torches were in quite general use in this building. These furnaces consist of a can holding about 20 gallons of gasolene, hav-

ing on the top an outlet which supplies four burners. These burners give out from time to time and in replacing one of them the indications are that in screwing the burner in the thread was badly damaged.

At 9.30 a. m. the burner suddenly let go and a jet of burning gasolene shot across against the gas meter located on the wooden wall of the building. This meter quickly gave way thus allowing the gas to flow freely from a two-inch pipe. This gas immediately ignited and spread the flames throughout the building. The only shut off on the gas pipe mentioned was inside the building and it was some time before same could be closed. Meanwhile the flames had spread throughout the building so that two thirds of the roof and of the monitor, the elevator tower and galleries are badly charred and a considerable portion of same will have to be rebuilt.

3. ROOMS IN WHICH FIRE OCCURRED.

	Common Causes.	Special Hazards.	Unknown.	Total Fires.	
	No. of Fires.	No. of Fires.	Incendiary, Exposure No. of Fires.	No. of Fires.	Per Cent.
Storage and Non-Manufacturing	49	8	53	110	17
Boiler Room	44	3	10	57	9
Engine or Dynamo Room	20	..	8	28	4
Fuel Oil Tank or Pump Room	2	..	2	4	..
Oil Room	7	4	2	13	2
Metal Chip Bin	1	1	..	2	..
Charcoal Shed	..	3	3	6	..
Coal Shed or Bin	5	..	1	6	..
Acid Storage	..	4	1	5	..
Forge and Smithy, (Welding, Rivets, Etc.)	14	26	8	48	7
Metal Bending and Breaking	1	..	1	2	..
Pickling Room	3	1	..	4	..
Annealing or Furnace Room	1	20	2	23	3
Tempering or Hardening Room	..	19	3	22	3
Rolling and Wire Drawing Room	4	8	1	13	2
Boiler Shop	..	..	1	1	..
Brazing Room	..	..	1	1	..
Tinning Room	1	7	2	10	1
Soldering Room	..	4	..	4	..
Machine Shop or General Metal Working	32	22	23	77	12
Tumbling Room	1	..	2	3	..
Testing Room	2	2	1	5	..
Pipe Shop	3	1	1	5	..
Black Lead Department	2	..	..	2	..
Japanning or Enameling Room	2	52	4	58	9
Painting and Varnishing Room	13	8	4	25	4
Lacquering Room	..	10	1	11	2

Plating Room,	1	6	2	9	..
Buffing and Polishing Room (Buffing Dust House)	7	24	8	39	6
Pattern and Carpenter Shop	9	2	6	17	3
Sawdust and Shaving Storage	2	3	..	5	..
Dry Kilns	2	10	..	12	2
Printing and Lithographing	3	..	..	3	..
Chemical Laboratory	1	2	..	3	..
Roof	11	1	6	18	3
Chimney	2	..	1	3	..
Flag Staff	5	..	..	5	..
Etching Room	1	1	..	2	..
Waste (Cotton) Reclaiming Room	..	1	..	1	..
Celluloid (Jewelers) Room	..	2	..	2	..
Engraving Room	1	..	..	1	..
Washing Oil from Filings	1	..	..	1	..
Total with data given	253	255	158	666	
No data	52	41	59	152	
Total	305	296	217	818	

Percentages not noted where less than 1%.

4. DAY OR NIGHT. (Day Fires 6 a. m. to 6 p. m.)

	Special Hazards.		Common Causes.		Unknown. Incendiary, Exposure		Total Fires.	
	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.
Day	162	57	118	40	63	30	343	43
Night	121	43	178	60	150	70	449	57
Total with data given	283		296		213		792	
No data	13		9		4		26	
Total	296		305		217		818	

5. PLANT IN OPERATION.

	Special Hazards.		Common Causes.		Unknown. Incendiary, Exposure		Total Fires.	
	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.
Plant in operation	115	67	63	37	37	25	215	44
Plant not in operation	58	33	108	63	113	75	279	56
Total with data given	173		171		150		494	
No data	123		134		67		324	
Total	296		305		217		818	

6. HOW DISCOVERED.

	Special Hazards.		Common Causes.		Unknown. Incendiary, Exposure		Total Fires.	
	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.
Employee	123	66	68	35	48	29	239	44
Watchman	35	19	68	35	52	32	155	29
Thermostat	1	1	7	4	3	2	11	2
Sprinkler Alarm.	8	4	15	8	14	9	37	7
Outsider	19	10	33	17	46	28	98	18
Total with data given	186		191		163		540	
No data	110		114		54		278	
Total	296		305		217		818	

SPRINKLER FIRE RECORD.

7. EFFECT OF SPRINKLERS.

	No. of Fires.	Per Cent. of Whole.
Extinguished or practically extinguished fire	247	65
Held fire in check	115	30
Unsatisfactory	20	5
Total	382	

8. DETAILS OF UNSATISFACTORY SPRINKLER FIRES.

894. April 10, 1900. Cleveland, Ohio. Stamping Works. Fire occurred at 6 p. m. about twenty minutes after employees had left building. Cause unknown. Prompt alarm and arrival of fire department. It is stated that an insurance representative and also the factory superintendent requested the fire department to make use of the steamer connection but this was refused. Fire started in the paint department on the fourth floor and finally gutted all above the second floor. Risk was completely equipped with sprinklers and system generally satisfactory except water supply was somewhat weak. Dry system with gravity tank giving about 20 pounds pressure on the sprinklers that opened and a weak waterworks supply. Because of this light water pressure and the limited supply, also the hazardous occupancy of the painting department, the fire got beyond control of the sprinklers. It is not definitely known whether the tank was full. Sprinklers were known to have opened and dry valve operated.

Summary: Light water pressure.

1067. August 8, 1900. Beaver Falls, Pa. Rolling, Wire and Tube Mill. Fire started in basement of main building. Joisted ceiling, basement vacant. Cause unknown. Risk was equipped with Neracher sprinklers, dry system, two Clapp dry valves. Good water supply being 10,000 gallon tank and six-inch city connection, 60 pounds

pressure. Sprinkler system supposed to have been in service. Risk totally destroyed. No data on which to base any conclusion as to the reason for the unsatisfactory action of the sprinklers.

Summary: No data.

1130. October 27, 1900. Oil City, Pa. Machine Shop. Fire started on top floor. Cause unknown. Was discovered by watchman at about 1 p. m. Employees used outside hose, but the town pressure was so light that the streams were of no value. It seems that at just that time the city authorities were flushing hydrants which cut down the town pressure to a point where it was ineffective. Risk was equipped with Gray sprinklers supplied by town water only and as already mentioned this supply was ineffective. There was no second supply.

Summary: Deficient waterworks supply.

M-2-19-01. Meriden, Conn. Cutlery Works. At 8.15 p. m. fire occurred in the shear shop. A man in the basement was dipping the handles of shears into asphaltum varnish. In some way the varnish was set on fire by a kerosene lamp which was hung on a nail almost over it. Whether the lamp fell or was knocked down is not known. The fire at once blazed up and entered the concealed space behind the sheathing which led to the top of the building. The man threw on a bucket of water and then ran to give the alarm. Neither the man at work nor the watchman thought of opening the valve which shut off the sprinklers in this building during the cold weather. By the time the public department arrived most of the roof was ablaze. The fire was extinguished in about an hour by means of hose streams.

Summary: Water shut off on account of cold weather.

1526. August 24, 1901. Cincinnati, Ohio. Sheet Metal Worker. Fire occurred in iron-clad re-tinning shed adjoining main building. This shed was not equipped with sprinklers. Fire spread to elevator shaft in main building and then to the various floors and opened a total of 235 sprinklers. Risk was equipped with Grinnell glass disc sprinklers, dry system, supplied by city water 55 pounds pressure and gravity tank. Fire engines reduced the city pressure making it ineffective and the gravity tank was soon emptied. Fire was finally controlled by the fire department with a loss of about 10% on the total value.

Summary: Unsprinklered portions.

2047. December 14, 1902. Boston, Mass. Machine Shop. Fire started on second floor of a tenant risk, this floor occupied as a machine shop. Fire was mostly held in check by the sprinklers but was not promptly discovered. Watchman made a round at 7 p. m. when he discovered water running down the stairway. The fire department was called and without making a complete examination concluded that the fire had been extinguished and they shut the water off the sprinklers. The fire had spread from the second to the fifth floor around a post and through cracks in the floors and after the water was shut off it spread very rapidly. Before it was controlled the two upper floors were badly gutted.

There was an old type lever sprinkler alarm but it failed to operate. This fire illustrates the necessity for a thorough examination before water is shut off the sprinkler system.

Summary: Water shut off before fire was out.

2422. May 10, 1903. New York, N. Y. Machine Shop. Fire occurred at about 4 a. m. on first floor rear. Joist construction with sheathed ceiling. There was no watchman and it is not known whether the local sprinkler alarm operated or not. Fire was discovered by an outsider. Risk was equipped with Harkness pendant rectangular joint sprinklers, installed in 1890. Wet system. Spacing 12½ feet with, and 9 feet across joists. The only water supply was a 9,000 gallon gravity tank giving about 40 pounds pressure on the first floor. Fire seems to have started under a platform and obtained more or less headway before sprinklers opened also it soon spread into concealed space back of sheathing. This coupled with the old equipment, defective sprinklers, and small water supply, was amply sufficient to account for the unsatisfactory work of the sprinklers. Tank was emptied and sprinklers failed to hold fire in check.

Summary: Generally defective equipment.

2733. February 7, 1904. Baltimore, Md. Repair Shop. This risk was in about the center of the Baltimore conflagration and naturally the sprinklers were of little value.

Summary: Exposure fire.

3281. October 13, 1904. Syracuse, N. Y. Lantern Factory. Fire was in two-story frame storehouse. Sprinklers on dry system. When sprinklers operated water hammer broke some of the sprinklers in the main factory and water was shut off to prevent water damage. This allowed fire to spread and get beyond control. For details see Bulletin No. 8, January, 1905, Fire 61, page 56.

Summary: Water shut off before fire was out.

3498. December 2, 1904. Chicago, Ill. Machine Shop. Watchman heard sprinkler alarm and shut off sprinkler valve, thinking a sprinkler had broken. Fire started up again with sprinkler system out of service. For details see Bulletin No. 9, April, 1905, Fire 84, page 42.

Summary: Water shut off before fire was extinguished.

3540. January 16, 1905. Providence, R. I, Jewelry Factory. Water shut off sprinklers for some unknown reason. Fire was controlled by department with small loss.

Summary: Water shut off sprinklers.

3968. February 16, 1905. Taunton, Mass. Silverware Factory. Fire occurred in buffing dust chamber. There were two Parmelee heads in this chamber one of which opened but did not throw water because the opening was filled with small stones. Fire was controlled by hose streams.

Summary: Sprinklers clogged.

4609. April 9, 1905. New York, N. Y. Silverware Factory. Gray No. 2 sprinklers failed to operate. For details see Bulletin No. 10, July, 1905, Fire No. 126, page 52.

Summary: Defective sprinklers.

3704. May 2, 1905. Providence, R. I. Sewing Machine Factory. Sprinkler system in building in which fire occurred was shut off through negligence. Repairs on the system had been made sometime before the fire and valves had been left closed. For further details see Bulletin No. 10, July 1905, Fire No. 120, page 48.

Summary: Water shut off sprinklers.

4053. June 10, 1905. Brooklyn, N. Y. Sheet Metal Worker. Severe across street exposure fire overtaxed a weak sprinkler system. Light pressure city water and gravity tank. Old-style spacing and arrangement. For details see Bulletin No. 10, July 1905, Fire 133, page 53.

Summary: Exposure fire.

4097. July 6, 1905. Bridgeport, Conn. Machine Shop. Fire occurred in japan room. Watchman shut off sprinklers thinking it had been extinguished. Fire spread and was finally controlled by the fire department. For details see Bulletin No. 11, October 1905, Fire No. 154, page 27.

Summary: Water shut off before fire was out.

4432. December 18, 1905. Providence, R. I. Machine Shop. Boiler exploded and wrecked sprinkler sytsem in that part of the plant. Main building but little injured.

Summary: Boiler explosion.

4894. February 6, 1906. Virginia. Machine Shop. Fire occurred in pattern shop. This building was equipped with sprinklers but for some unknown reason the water was shut off at the time of the fire so that the sprinkler system was of no value.

Summary: Water shut off.

5615. January 29, 1907. Philadelphia, Pa. Locomotive Works. Fire occurred in paint shop. Water was shut off sprinklers at time of fire for some unknown reason. For details see Bulletin No. 17, April 1907, Fire No. 5615, page 44.

Summary: Water shut off.

5861. March 25, 1907. Cincinnati, Ohio. Sheet Metal Worker. Fire occurred in east section of No. 1 Warehouse. Sprinklers were badly obstructed by stock piles. Risk equipped with Grinnell type "A" sprinklers, old standard, with gravity tank giving 10 pounds pressure. Dry system. Sprinklers failed to hold fire in check owing to the obstruction to distribution and the generally defective equipment. For further details see Quarterly No. 1, Vol. 1, July 1907, Fire No. 5861, page 73.

Summary: Generally defective equipment.

Water shut off sprinklers	9
Deficient water supply	2
Generally defective equipment	2
Exposure fire	2
Defective sprinklers	1
Sprinklers clogged	1
Unsprinklered portions	1
Boiler explosion	1
No data	1
Total	20

9. DETAILS OF LARGE LOSS SPRINKLER FIRES. (Where sprinkler control is satisfactory.)

1594. October 26, 1901. Meriden, Conn. Silverware Factory. Fire occurred in concealed space of attic in an old wooden building. There were sprinklers in these concealed spaces but it appears that they were shut off at time of fire because of the danger of freezing. Fire spread in concealed space and in all 59 sprinklers opened finally holding fire in check. Loss about $5,000.

Summary: Concealed spaces.

M-3-15-92. Silverware Factory. Fire started in a barrel of pitch in the plating room, the cause being unknown. The fire went through a window, and over the boilers to the casting room, where the principal loss was caused to the metals. This pitch room was built outside the works, but the masons omitted to brick up this window. The fire was extinguished by 26 Grinnell automatic sprinklers and streams from fire hose, after lasting thirty minutes. Loss $7,269.39.

Summary: Unsprinklered portions.

1747. February 14, 1902. Providence, R. I. Manufacturing Textile Machinery. Fire occurred in first story of wooden building used for painting the metal work of textile machines. Caused by the ignition of black japan paint, and fire spread quickly getting into the sheathed wood walls. It was supposed that fire was out and water was shut off the sprinklers, but fire had worked into the floors above and sprinklers were turned on again finally holding the fire in check. Loss about $19,000.

This fire emphasizes first, that naphtha fires spread quickly and are liable to cause considerable loss where the process is carried on in the main building, even if the sprinklers do all that can be expected of them; second, that wood sheathed walls are thoroughly undesirable; third, that fire department or others should not shut water off sprinklers until they are certain that fire is extinguished.

Summary: Concealed space.

1805. February 15, 1902. Chicago, Ill. Machine Shop. Fire occurred on rear of first floor occupied for storage of light metal and wood parts. Risk was equipped with old Clapp sprinklers, dry system, Grinnell

valve. Primary supply 3,000 gallon pressure tank giving about 75 pounds pressure on sprinklers, and a 600 gallon fire pump as a second supply. Thirty-three sprinklers opened and held fire in check. Hanging racks obstructed the distribution and permitted fire to spread and open up a large number of sprinklers. Loss about $8,000.

Summary: Obstruction to distribution.

2061. December 24, 1902. Buffalo, N. Y. Wire Mattress Factory. Fire occurred in japan dipping room. Caused by lighted gas jet over dip tank. Fire spread rapidly and opened all of the sprinklers in the room. Fire also spread into concealed space at ceiling and was difficult to extinguish. Loss about $5,000.

Summary: Dip tank fire.

5326. May 3, 1906. Meriden, Conn. Brass Worker. Fire spread into attic through the ventilating flue. Attic was of pitch roof construction with dormer windows, and was very much crowded with stock piled up above the sprinklers and close to the eaves. There were four lines of sprinklers, old spacing and arrangement, with no line in the peak. Fire spread in this attic owing to the obstruction to distribution and defective arrangement of the sprinklers. Loss about $13,000.

Summary: Obstruction to distribution.

M-8-1906. Enameled Ware. At about 2 a. m., from an unknown cause, a slight fire occurred in the finished stock room on the top floor of Building No. 14. The fire started in the middle of the racks and open shelves where unfinished tin and enameled ware were stored, wrapped ready for packing. The sprinkler directly over the fire did not open, but 18 others in two bays did, causing a great flood of water, which did much damage to goods on the floor where the fire started and much more on the floor below, where the entire storage was tin and steel ware. Although prompt attention was given, rusting started before wrappers could be removed. The fire damage was practically nothing; damage by water, $7,000 to $10,000.

Summary: Obstruction to distribution.

6119. May 22, 1907. New York, N. Y. Metal Worker. Fire spread along joist channels and up through floor. Defective spacing and not staggered. Loss over $6,000.

Summary: Defective spacing.

10. POINTS OF INTEREST FROM SPRINKLER FIRE REPORTS.

Concealed Spaces.

114. Fire started in a concealed space between the walls of a brick and wood building on the first floor. When the brick building was built a space of one foot was left between the brick and wood walls. This wooden wall had a brick japan oven built against it, also a chimney, and it is supposed that the wood against this oven became charred and ignited. Owing to the location of the fire the sprinklers could not reach it but kept it from spreading.

1661. Sprinklers were unable to extinguish fire in small pockets between joists above wood ceiling.

M-4-18-01. Fire occurred in scale and packing room caused by gas burner swinging against shelf. The fire appears to have run up the edges of the shelf, through cracks in the sheathing below the attic floor joists and thence into the attic and through the roof. Four sprinklers operated in attic and held fire in check.

M-10-5-02. There was an intervening space of about six inches between the ends of the two buildings which had been roofed over and boxed in forming a concealed space. Sometime ago the section of joisted wall of No. 2 was replaced in the first story by a brick wall. Fire originated either in opposite building or in concealed space from some unknown cause and when discovered must have been burning for some time. From the top of the brick wall the fire worked its way up the sides of both buildings to the roofs but was prevented from entering the buildings by automatic sprinklers.

Construction.

4836. The concrete floors proved to be very porous, letting considerable water through, doing much damage to floors below.

Cut Off.

M-2-3-91. A brick division wall was of great service in stopping the fire.

Dry System.

M-1-26-92. The automatic sprinklers opened promptly but did very little good on account of the time required to discharge the air from the dry-pipe system.

Fire Department.

M-1-25-95. After fire was out the city fire department brought in a stream and used the same for about five minutes causing considerable water damage.

Floor Openings.

1722. Elevator which was supposed to be left at first floor to take the place of a trap had been run up to top leaving a chance for fire to work its way up elevator well to second floor.

M-4-24-93. Fire occurred in oil room in basement and spread through a small open stairway to upper floors and mansard roof.

Gate Valves.

989. Gate valve to shut off water to sprinkler system was in an inaccessible position and water could not be shut off until three hours after the fire was discovered.

3281. Sprinklers failed to extinguish fire due to shutting of gate valve too soon.

Hose.

M-1-4-95. The first line of hose put on burst at once, causing a delay of about three minutes in the use of the apparatus, otherwise it is thought the fire would have been extinguished at once with small loss. Two other breaks also took place in one of the other lines of hose. The present hose houses are small boxes in which the hose is folded closely and this in connection with the cold weather may have led to this result.

Obstruction to Distribution.

1805. Hanging racks obstructed distribution from sprinklers, permitting fire to open a large number of heads.

M-8-19-06. Fire started in the middle of the racks and open shelves where finished tin and enamel ware was stored, wrapped and ready for shipment. Shelves and racks prevented water from reaching fire and in all 18 sprinklers opened causing heavy water damage.

Private Brigade.

M-9-20-06. The employees made no attempt to get a stream on the fire, the mill fire pump was not started. As near as can be learned some 10 to 15 minutes elapsed before hose streams were brought into play.

Outside Sprinklers.

M-2-10-07. The end of risk towards exposure was equipped with fire shutters and cornice sprinklers at the sixth and eighth stories. These sprinklers were fed from the main riser and were controlled by a valve on the seventh floor. The valve was promptly opened by night watchman and eight sprinklers continued in action about three hours. According to all testimony, including that of chief of fire department, these sprinklers were instrumental in keeping the fire out of the building.

Automatic Sprinklers.

M-6-24-07. Fire caused by watchman slipping and dropping his lantern into paint dip tank which took fire. Two sprinklers operated instantly and extinguished fire. While it has never been doubted the efficiency of an automatic sprinkler system in preventing the spread of a fire occurring in a paint tank, yet it has been considered doubtful whether it would wholly extinguish it. In this case it will be noted that the fire was extinguished at once by the water from two sprinklers.

Spacing.

M-5-3-06. There were four lines of sprinklers in the attic, the pipes running longitudinally with about 11 heads on the line from the central feed pipe. There was no line in the peak and all heads on the southerly central line at the east had been removed. All of the sprinklers in the two middle lines, including the dormer windows and five sprinklers at the east end on each of the lines operated. The crowded condition of the attic and

the imperfect arrangement of the sprinkler system would account for the spread of the fire and for the large number of sprinklers opened.

2991. Fire succeeded in passing between four lines of sprinklers midway between the sprinklers on lines, part open joist construction. One sprinkler marked 286°, which was directly in path, was not opened although the joists were scorched on all sides and pipe hangers had become loosened.

Steamer Connection.

2061. A pleasant feature was the work done by the fire department in connection with the sprinkler equipment. Connection was made between the second engine to arrive and the outside connection to the sprinkler equipment and very effective work was the result. This is the first case on record where the department here has made use of one of these steamer connections.

Underground Piping.

6065. The sprinklers operated first, were effective in holding the fire in check and would have extinguished it, but cinders which had carelessly been left in the underground piping when it was laid were carried to the open sprinklers and clogged them, allowing the fire to gain headway. The firemen could not enter the burning building, but coupled to a private yard hydrant and fought the fire from the passageway to adjoining building and roofs of same. They were compelled, however, to remove the hose nozzles several times in order to clean out the cinders which almost completely stopped the flow of water. The fire was finally extinguished, but the department was recalled a few hours later to extinguish a small fire which had rekindled in the second floor. Had the underground piping been free of cinders, the pump in automatic service and the riser fitted with an approved alarm valve, the fire would undoubtedly have been extinguished upon the opening of only a few sprinklers.

The installation of the sprinkler equipment was recent and not fully completed.

Unsprinklered Space.

M-10-31-06. Fire occurred under floor of finishing room of rolling mill. This space was not sprinklered and fire spread underneath the floor badly damaging the same.

Water Shut Off to Prevent Freezing.

M-2-19-01. Water shut off sprinklers in shear shop to keep system from freezing. Fire caused by ignition of varnish from kerosene oil lamp. Man threw on a bucket of water and then gave the alarm. Neither the man at work nor the watchman thought of opening the valve which shut the water off sprinklers. Building destroyed.

11. NUMBER OF SPRINKLERS OPENED.

No .of Sprinklers Operating.	Extinguished Fire. No. of fires.	Extinguished Fire. Per cent.	Held Fire in Check. No. of fires.	Held Fire in Check. Per cent.	Unsatisfactory. No. of fires.	Total. No. of fires.	Total. Per cent.	No. of Sprinklers Operating.	No. of fires.	Per cent. of whole.
1	117	47	26	23	1	144	38	1	144	38
2	40	16	26	23	1	67	18	2 or less	211	56
3	28	11	11	10	..	39	10	3 or less	250	67
4	15	6	12	11	..	27	7	4 or less	277	74
5	9	4	11	10	..	20	5	5 or less	297	79
6 to 9 inc.	16	6	10	9	..	26	7	Less than 10	323	86
10 to 24 inc.	18	7	7	6	3	28	8	Less than 25	351	93
25 to 49 inc.	2	1	3	3	..	5	1	Less than 50	356	95
50 and over	1	1	8	7	11	20	5	50 and over	20	
Total	246		114		16	376				

Average number of sprinklers opened not including unsatisfactory, 6.0.

12. ALARM SERVICE.

	Satisfactory. No. of Fires.	Satisfactory. Per Cent.	Failure. No. of Fires.	Failure. Per Cent.	Total.
Watchman alone	45	92	4	8	49
Sprinkler alarm alone	24	83	5	17	29
Thermostat alone	1	100	..	..	1

	Watchman. Satisfactory.	Watchman. Failure.	Sprinkler Alarm. Satisfactory.	Sprinkler Alarm. Failure.	Thermostat. Satisfactory.	Thermostat. Failure.	Total.
Watchman and Sprinkler Alarm	20	21*	32	9	..	..	41
Watchman and Thermostats	1	..	..	..	..	1	1
Sprinkler Alarm and Thermostats	..	..	8	..	7	1	8
Watchman, Sprinkler Alarm and Thermostats, ...	1	1*	2	..	1	1	2

*These include fires where sprinkler alarm or thermostats notified the watchman.

Note.—These tables do not include fires where alarm service does or does not operate properly if fire is at once discovered by employee, the alarm service having no bearing on such fires one way or the other.

Points of Interest from Fire Reports as Regards Alarm Service.

461. Sprinkler bell connected with central station failed to ring on account of weak batteries.

2044. Water motor alarm failed for lack of lubrication and exposure to weather.

6065. As there was no alarm valve in sprinkler riser the fire was not discovered; the water was seen running out of door in first floor.

2191. Sprinkler alarm failed to operate on account of hammer on gong being broken.

1059. The risk was without alarm service and fire occurred sometime in the night. No fire loss to stock which consists of sheet metal, and water loss would have been slight if fire had been discovered promptly.

1819. There was no watchman on the premises. The alarm valve did not operate and water ran for some time causing water damage on all floors.

M-4-10-91. The watchman is supposed to have been through the room 25 minutes before the alarm was given, but he did not know of fire until the city fire department was at the gate.

M-9-30-91. Watchman failed to discover fire. Had made his round a short time previous and was in another part of risk when fire was discovered.

M-2-23-92. Fire occurred at 8.55 p. m. The watchman visited a station which was within two feet of the place where fire started at about 8 o'clock and was next to visit it at 9 o'clock. Watchman failed to discover fire.

M-8-13-95. Fire broke out in barrel of wood and kindlings in boiler room. The thermostat overhead immediately rang the alarm and the firemen from adjacent engine house at once responded and extinguished the fire.

M-9-20-06. Watchman also discovered the fire and turned in Central Station alarm. This alarm was not responded to and later he turned in the city alarm which was quickly responded to with four steamers and a second alarm bringing eight more.

13. SECONDARY WATER SUPPLIES.

1526. Primary supply city water 55 pounds pressure. Secondary supply gravity tank. Fire started in unsprinklered portion and fire department reduced waterworks pressure and gravity tank was soon emptied. Failure.

1805. Primary supply 3,000 gallon pressure tank, secondary supply 600 gallon fire pump. Thirty-three heads opened and steam pump was of value in maintaining pressure and holding fire in check.

2061. Primary supply 500 gallon automatic pump, second supply steamer connection. Japan dip tank fire opened up 67 heads. Fire department connected to the sprinkler system and aided the steam pump in maintaining a good working pressure on the sprinklers.

2991. Primary supply 4,500 gallon pressure tank, second supply 8,000 gallon gravity tank. Five sprinklers opened and water used from both supplies. Owing to length of time that sprinklers ran second supply was used but it probably was not a factor in extinguishing fire.

6065. Primary supply gravity tank, second steam pump. Fire spread, due to clogging of sprinklers with cinders so that 96 heads opened. Steam pump was used and was of good service in maintaining proper pressure on the sprinklers so that fire was finally held in check.

14. EFFICIENCY OF WATER SUPPLIES.

Primary Water Supply.	Number of fires	Per cent. of fires	Average Pressure	Average number Spkrs. opened	Per Cent. of Fires. Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Average Pressure. Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Average Number Sprinklers Opened. Extinguished fire (or practically extinguished)	Held fire in check
Water works,	167	56	63	5.7	66	26	7	62	67	53	3.7	10.8
Gravity tank,	59	20	20	5.5	64	31	5	22	15	19	1.8	13.2
Pressure tank,	48	17	93	2.7	85	13	2	93	91	80	3.0	2.6
Automatic pump,	21	7	67	20.5	72	28	0	64	75	0	10.6	45.1
Total,	295		59	6.3	70	25	5	61	57	48	3.7	13.7

15. EFFICIENCY OF WATER PRESSURES.

Pressure on Sprinklers.	Number of fires	Per cent. of fires	Average Pressure	Average number Spkrs. opened	Per Cent. of Fires. Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Average Pressure. Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Average Number Sprinklers Opened. Extinguished fire (or practically extinguished)	Held fire in check
Less than 15 lbs.,	14	5	10	1.9	28	58	14	10	10	9	2.0	1.9
15 to 24 lbs. inclusive,	35	12	19	1.6	72	22	6	19	17	18	1.4	2.7
25 to 49 lbs. inclusive,	58	20	37	4.5	79	14	7	38	36	36	2.5	15.7
50 lbs. and over,	188	63	78	8.0	70	26	4	78	75	71	4.6	17.1
Total,	295		59	6.3	70	25	5	61	57	48	3.7	13.7

16. EFFICIENCY OF WET OR DRY SYSTEM.

Wet or Dry System.	Number of fires	Per cent. of fires	Average Pressure	Average number Spkrs. opened	Per Cent. of Fires. Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Average Pressure. Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Average Number Sprinklers Opened Extinguished fire (or practically extinguished)	Held fire in check
Wet system,	214	73	58	4.6	69	26	5	61	56	45	2.2	11.1
Dry system,	81	27	62	11.1	71	22	7	63	60	52	7.8	21.6
Total,	295		59	6.3	70	25	5	61	57	48	3.7	13.7

Note—"Average number of sprinklers opened" does not in any case include the Unsatisfactory fires.

General Fire Record.

FIRE-PROOF BUILDINGS FIRE RECORD.

H-1966. New York, N. Y. December 13, 1907. Candy Factory. Fire occurred at 7.10 p. m. in the ninth story of a ten-story so-called fire-proof building, the two upper stories of the building being occupied as a box shop, the lower stories for the manufacture of chocolates and candies. The fire is interesting in illustrating the effect upon so-called fire-proof construction and thoroughly illustrates the need of automatic sprinklers in such buildings wherever there is any combustible occupancy.

The fire was confined to the storage compartment, in which it originated, its fuel being finished, empty paper candy boxes and flat paper stock piled high, also a considerable amount of light woodwork in the shape of shelving, racks and partitions. On account of the tightness of the compartment and consequent accumulation of smoke and gases, the fire was fought with great difficulty as hose streams had to be used at close quarters from the fire door openings and through two holes broken through the ceiling. The rapid prostration of the firemen prevented quick control of the fire.

The building is of the Roebling type, ten stories in height, of fire-proof construction, having columns of structural steel protected by hollow tiling and covered with about three-fourths-inch of cement. The main girders are protected on the sides and beneath by plaster held in place by wire netting as are also the smaller beams supporting the floor between the girders. The floors are of cement concrete, about six inches thick. The windows in the south and east sides were of wire glass in metal-covered wooden frames. The enclosures at the stair and elevator towers are hollow tiling covered with plaster.

The visible effects of the fire were:

The partial destruction of the outer coating of plaster on the beams and girders, leaving netting exposed, and crumbling and dropping of plaster from inside the netting in a few places, leaving the lower sides of the steel beams partly exposed.

Destruction of the cement coating covering the tiling at the columns, leaving the tiling exposed.

Bending of an exposed angle iron forming the corner of the hand elevator shaft.

Burning of the metal-covered wooden framing of the windows which fell inward on the east side.

There was no distortion of the columns or girders which could be detected with the unaided eye.

The floor leakage was very slight and appeared only at a few places at the side walls, the main body of water used running down the stairway and elevator. The management state that the wire glass windows at the tenth story formed an effective barrier to the flames which passed through the ninth story windows in the south wall after the latter were broken out.

Lessons: The important lesson of this fire is the need of automatic sprinklers.

The fire also demonstrated well the value of fire resisting covering for steel work, of water-tight floors, and of wire glass windows against exposures from stories below.

UNSATISFACTORY OR SERIOUS FIRES IN RISKS EQUIPPED WITH SPRINKLERS.

6215. Chelsea, Mass. September 26, 1907. Cordage Works, Fire occurred in the tar house adjoining main building. Frame construction occupied for storage of old machinery. Cause was probably incendiary. Risk was equipped with Grinnell glass disc sprinklers, old pipe sizes, supplied by water-works giving 65 pounds pressure and a gravity tank. Fire in some way got beyond control of the sprinklers, possibly due to the tar-soaked woodwork, and the fact that sprinkler lines were run at right angles to roof timbers, which made the distribution poor so far as ceiling was concerned.

Summary: Not classified.

6214. Spencer, Mass. October 4, 1907. Woolen Mill. Fire started over the top of a Heathcote dryer in the first floor of addition and spread through unprotected doors and belt holes to floor above. In all 220 sprinklers were opened and fire was finally controlled by the fire department. Risk was equipped with Walworth sprinklers of various types supplied by water-works giving 100 pounds pressure. Wet system. The sprinklers in the dryer and also some in that vicinity were high test and at least two were wired closed. Furthermore five of the sprinklers were of the Walworth upright pattern placed pendant. The most probable cause of the failure seems to have been the failure of the high test heads and those wired closed so that fire was allowed to obtain considerable headway. Floor openings also played an important part in the spread of the fire.

Summary: Defective sprinklers. (Part high test.)

6221. Superior, Wis. November 8, 1907. Grain Elevator. Elevator "A." For details see report on fire at Superior, Wisconsin. Fire started on dock and spread into unsprinklered basement. Except for this basement, elevator was equipped completely with an old-style sprinkler system with good water supplies. There was considerable obstruction to distribution in the first story and fire got beyond control. Total loss.

Summary: Unsprinklered portions.

6222. Superior, Wis. November 8, 1907. Grain Elevator. Freeman Elevator. Risk burned from exposure fire which inside sprinklers could not hold. For detail see fire report of fire at Superior, Wis.

Summary: Exposure fire.

6223. Superior, Wis. November 8, 1907. Flour Mill. Freeman Flour Mill. Risk burned from exposure fire which inside sprinklers could not hold. For details see fire report of fire at Superior, Wis.

Summary: Exposure fire.

6219. Pelzer, S. C. November 20, 1907. Cotton Mill. About

two weeks before this fire started, 52 bales of waste were sold and loaded on cars but the railroad refused to accept them for shipment at that time. They were placed in the southwest corner of the second floor of Warehouse No. 10. A few days after, 25 bushels of oats were added. The house was not again entered until the time of the fire.

The yard watchman visited the north side of the warehouse just before one o'clock. A few minutes later fire was discovered coming from the rear of the building by the watchman at an oil plant several hundred feet distant and he gave the alarm.

As previously instructed, the fire brigade were assembled at once and carried out hose from the hydrants near the warehouse. One watchman went to the steam fire pump and another employee closed the valve under the large tank in the yard, as this was necessary in order to obtain a good fire pressure from the pumps, there being no by-pass around the check valve and the clapper having been removed in order to fill the tank. This valve remained closed during the fire; and the only other supply available when the pumps were not running was from the small tanks in the mill towers. The steam fire pump was under control of an automatic governor on a by-pass, and was found running when the watchman arrived, but he did not open the main throttle to the pump as he should have done.

The first stream was put on in about five minutes, others quickly following until four were running. These were directed through the doors and the rear wall, the boards of which were torn off to gain better access. This undoubtedly weakened the building, as the floor carrying the waste fell while this was being done. Very shortly afterwards the pressure suddenly dropped and two streams were shut off. It was then discovered that in falling, the floor had broken a 2½-inch sprinkler pipe, and so much water was being wasted that it was thought best to shut off the supply to the sprinklers and the valve was not opened again during the fire.

In the meantime the engineer had reached the steam pump, found it racing, and was obliged to shut it down, which was the cause of the sudden drop in pressure above mentioned, as then the hose streams were being supplied from only the tanks in the towers. Orders were immediately given to start the rotary fire pumps, and in about ten minutes the pumps were running with four streams again in service.

At 2.30 the fire was out, except what was smoldering in the bales of waste.

An immediate examination of the steam pump showed that one of the valve seats had unscrewed from the lower deck, causing the pump to lose its suction and race. Repairs were immediately started but it was four o'clock before the pump was again in commission and able to throw water on the smouldering bales. Temporary repairs could have been made by bolting a block of wood over the hole in the deck and thus securing the use of the pump throughout the fire with very little time lost.

The sprinklers in the warehouse were on a 4-inch Grinnell dry-pipe valve, with hydraulic alarm attached. The alarm did not operate, as the three-way test cock in the supply to it was closed. The dry-pipe valve was arranged as ordinarily on a by-pass, and the valve in the main line was not opened during the fire.

The fire may possibly have been caused by spontaneous combustion in the baled waste, which included sweepings.

Previous to the installation of the dry-pipe system in this equipment in 1906, the sprinklers had been shut off during cold weather ever since they were first installed in the building, about 1890. As a result of the repeated draining and refilling of the system year after year, probably twenty times at the least, it is possible that sufficient scale and sediment had accumulated in the smaller pipes to interfere with the proper action of the sprinklers, especially at the start of the fire when only tank pressure was available. This, together with the fact that there were more or less cracks between the boards forming the side of the building, may account for the appearance of the fire on the outside of the building, especially since the fire started near this wall and under that part of the system where the accumulation of sediment would be most liable and where it would have most effect on the sprinklers as the pipes there were smaller, moreover the wind being from the north and quite strong, would naturally tend to drive the fire through the cracks in the southerly wall.

It would be advisable to examine the pipes in the other section of this storehouse to make sure that these are not obstructed by scale or sediment.

During the interval while the pumps were not running and the large tank and sprinklers were shut off, and the only water supply was from the small tanks in the towers, the fire gained such headway that later it was not possible to save the building and it was practically destroyed.

Summary: Steam pump disabled.

6218. Whitehall, N. Y. November 28, 1907. Silk Mill. In the rear of the main mill and adjoining the same on the river side was a two-story frame building of light construction, occupied in the first story as a boiler house and in the second story by the picking, drying and filling machines. At 2.30 a. m. the watchman, while passing through the first story of the main mill, discovered smoke coming up the elevator way. Upon investigation he found fire in the filling engine room over the boiler room. The cause of the fire is unknown, but it was probably due to the heat from the boilers igniting picking waste on the floor above. The watchman immediately gave both the public and private alarms, which were responded to by the master mechanic, employees of the mill, and also by the public fire department, who brought five hose streams into play from the yard hydrants and from the standpipe in the tower, extinguishing the fire after several hours' duration.

The building where the fire occurred was equipped with automatic sprinklers, but the water had been shut off from those in the second story a few days previous because of the danger of freezing, and as the watchman was unaware of this fact no attempt was made to turn the water on until the arrival of the master mechanic, by which time the valves were inaccessible due to the smoke. Several of the windows on the rear of the main mill were destroyed by the flames, and the fire worked into the basement and into the first story of the mill, opening four sprinklers in the basement and two in the

first story. These sprinklers having an excellent water pressure, formed a water curtain at the windows and prevented the spread of the fire into the main mill which is but slightly damaged. The steam plant is intact and immediate steps were taken to protect the same so that the boilers could be started and the mill operated. The building in which the fire occurred, was as is stated above, of very light construction, and plans had already been made at our suggestion to rebuild the same of the best type of construction. This work would have been done during the past season had it not been for the large expenditure, due to the extension of the main mill.

This fire illustrates in a practical way the dangers attending shutting off water from the sprinklers in winter time from any of the manufacturing buildings. Sufficient heat should be provided in all cases so that there will be no necessity of doing so. In fact, in the present instance it is probable that there would have been little or no danger of the sprinkler pipes freezing if the same had been kept on. In addition, wherever any valves are closed for any purpose whatsoever, the watchman should be advised of the fact, so that he may open them in case trouble occurs. Loss, $6,000 to $10,000.

Summary: Sprinklers shut off to prevent freezing.

Sprinkler Fire No. 6216.

6216. Buffalo, N. Y. December 2, 1907. Car Shop. Fire occurred in painting and finishing building one high story, wood truss roof, slate covered, brick walls. Building was 455 feet long and 150 feet wide, divided into three sections by brick walls which did not

extend through the roof. Fire started in middle section which was 180 feet long. Building contained twenty Pullman cars undergoing repairs, nine of these being in the middle section. Fire started in a car close to fire wall dividing the middle section from the north section. Workmen had just left the car on the next tracks and fire was discovered soon after they had gotten out of the building. Fire spread with great rapidity and all three sections with contents were destroyed. Cause unknown.

This building was equipped with John Kane "bulb root" sprinklers. Wet system. One six-inch connection for the entire building, Primary supply 9,000 gravity tank elevated 30 feet above top line. Second supply 1,000 gallon Underwriters fire pump taking suction from a 90,000 gallon cistern, the latter being filled from a four-inch connection from city main. It appears that alarm was given promptly and pump started and kept operating under full pressure. There were 108 sprinklers in the middle section, all of which were opened. The sprinklers had apparently no effect on the fire. The failure of the sprinklers is accounted for by the spread of the fire under the cars where the water could not reach, also the height of the sprinklers above the cars, and the fact that all the sprinklers in the building must have operated almost immediately after the fire broke out of the first car. The exceedingly rapid spread of the fire is doubtless tributary to the inflammable vapors from the painting and varnishing hazard. It was only a short time after fire started before roof fell in and entirely crippled the sprinkler equipment in all of the sections.

The following points are emphasized. All division walls should be parapetted, and all openings should be protected by standard automatic fire doors.

Automatic sprinklers under roofs in this class cannot be relied upon for effective service.

Sprinklers should have outside control for each section of the risk.

Rooms or building where painting or varnishing is done should have proper ventilation.

Summary: Obstruction to distribution. (Car Shop.)

6210. New York, N. Y. December 3, 1907. Metal Worker. Fire occurred on the third story of a brick building, open joist construction. This floor occupied for manufacturing iron beds with dipping and painting. Fire started about midnight and thermostats and sprinkler alarm both operated. Risk was equipped with New York and New Haven Elbo No. 2 sprinkler, old style equipment. Spacing 10 by 10 feet under open joists not staggered. The only water supply was a 5,000 gallon gravity tank. The sprinklers were slow in operating and many of them failed entirely owing to resoldering. Water distribution poor. Fire spread to floors above and gravity tank was soon emptied.

Summary: Defective sprinklers.

6217. Manhattan, N. Y. December 6, 1907. Tenant Woodworker. Five-story brick joist construction building occupied as a power woodworker, box factory, and cabinet making. Risk equipped with Grinnell glass disc sprinklers, dry pipe system, Grinnell dry valve,

660 heads, spacing 8 by 10 feet not staggered. Considerable obstruction from patterns, lumber storage, etc. Old pipe sizes. The only water supply was a 6,600 gallon gravity tank 15 feet above top line of sprinklers, except there was a steamer connection. Fire occurred at about 2.25 a. m. on the next to the top floor and was discovered by a policeman who notified the watchman, the latter having been through this floor only a few minutes before. Watchman tried to extinguish the fire but failed, the policeman having in the meantime rung in the fire alarm. Firemen arrived quite promptly and by that time it appears that fire had spread into the fifth floor and was breaking through the roof. There was considerable delay (probably fifteen minutes or more) before the fire department could get water on the fire. The fire was finally controlled by the fire department, but the entire roof burned off and also a large part of the fifth and part of the fourth floors were burned. The fourth and fifth floors were occupied by a cabinet maker for making and finishing furniture and fire started in decorating room. Tank was found empty after the fire, valve open and dry valve properly tipped, nevertheless no one seems to have seen any sprinklers operating or to have noticed any water, which seems most peculiar. There was a large opening between the fourth and fifth floors and it is possible that fire spread too quickly for the sprinklers and overtaxed the water supply.

It appears that no attempt was made to use the steamer connection and it is quite possible had this been used the sprinklers would have controlled the fire.

Summary: Sprinklers out of service.

5895. Waterford, N. Y. December 16, 1907. Full Process Knitting Mill. Fire started about 3 a. m. and was discovered by an outsider. Watchman failed. Risk was totally destroyed. Investigation after the fire showed that gate valve controlling the sprinkler system was closed rendering equipment inoperative.

Summary: Water shut off sprinklers.

6220. Harrisville, R. I. December 19, 1907. Woolen Mill. Fire started in yarn dryer in one-story frame dye house building. Cause unknown. This dryer was equipped with Grinnell glass disc sprinklers 360°. Good water supply. Fire broke out of dryer and spread to stock bins and thence into attic of adjoining building. It was finally controlled by hose streams. Investigation showed that three of the four heads in the dryer were blocked up with small stones so that only one discharged water to any extent. This allowed fire to get considerable headway before the sprinklers outside could be of any service.

Summary: Sprinklers clogged.

6237. Chicago, Ill. December 25, 1907. Tenant Manufacturing. Six-story and basement, joisted brick building. Metal sheathed ceilings. Fire occurred about 6.20 a. m. and it appears that the fireman who was the only man on the premises heard the local sprinkler alarm and very shortly after noticed water coming down through belt holes into the basement. The possibilities are that he shut off the sprinklers as it appears that his instructions from the engineer were to first shut off the water and then investigate. The fire department chief

states that there was no water coming from the sprinklers when he arrived, and if the system had been in service there was no reason for it not holding the fire in check. The fireman probably thought that it was an accident to the sprinklers, shut off the water and later on saw his mistake and opened the sprinkler valve. By this time, however, the fire had spread up through the belt openings to floors above and had gained great headway. In all 600 sprinklers opened (about 120 per floor). Risk was equipped chiefly with Grinnell glass disc sprinklers, dry system, supplied by pressure tank of 3,000 gallons capacity and a 600 gallon automatic steam pump. There was also a steamer connection which was used and the sprinklers undoubtedly prevented the complete destruction of the building. The fire did not amount to much except on the upper floors and the roof and part of the fifth floor were burned through and collapsed.

Summary: Water shut off during fire.

LARGE LOSS SPRINKLER FIRES.

Where Sprinkler Control is Satisfactory.

6225. New York, N. Y. September 5, 1907. Manufacturing Linen Twines. Fire occurred in basement occupied for storage of dressed flax in racks. Probably caused by short circuit in drop cord of electric light. Open joist construction, risk equipped with Grinnell glass disc sprinklers, spaced 8 by 8 feet not staggered. Wet system with good water supply. Fourteen sprinklers opened and held fire in check. Owing to the obstruction to distribution from stock, fire was difficult to extinguish. Loss $9,000.

The following suggestions are in order.

Floors should be arranged to drain properly and all stock should be skidded at least six inches above the floor.

Slatted partitions should be cut down two feet from ceiling.

Summary: Obstruction to distribution.

6224. Providence, R. I. September 15, 1907. Woolen Mill. Fire started in unsprinklered one-story and attic, open joist frame storage shed. This shed was destroyed and fire attacked side of the factory entering through doors and windows. Five sprinklers opened and aided in holding the fire in check. This fire illustrates the necessity of installing sprinklers throughout risk. Loss $8,000.

Summary: Unsprinklered portions.

6228. Washington, D. C. September 21, 1907. Mercantile Risk. (Ladies' and Gents' Furnishings.) Fire occurred in second floor of brick building, hollow joist construction. Room occupied as a sales room, with stock of ladies dresses in show cases. One sprinkler opened and extinguished the fire. Water damaged the fancy dresses and ran through ceilings to floors below. Total loss $7,600.

Summary: Susceptible stock.

6227. Newark, N. J. October 3, 1907. Patent Leather Factory. Fire occurred on top floor of building No. 2, used for color mixing, daubing and drying of hides. Fire occurred at 5.30 p. m. just after em-

ployee had left. Risk was equipped with Grinnell glass disc sprinklers, good spacing and arrangement. Wet system.

Water supplies were a four-inch connection from city main giving twenty-five pounds pressure on top floor and gravity tank giving ten pounds.

All the sprinklers in the room, namely forty-five, opened, also three outside and held fire in check. There were a number of hides drying on this floor at the time of the fire and on account of the large quantity of volatile fumes in the room the fire spread rapidly. This is an excellent example of a hazardous occupancy fire controlled by light pressure water supplies. Loss $6,500.

Summary: Hazardous occupancy.

6226. Cambridge, Mass. November 15, 1907. Bookbinding. Fire was in stock room on second floor and was held in check by one sprinkler. This sprinkler ran about fifteen minutes before it was shut off and damaged a number of books. Loss about $7,500.

Summary: Susceptible stock.

OTHER SPRINKLER FIRES OF ESPECIAL INTEREST.

6230. Newark, N. J. July 10, 1907. Celluloid Factory. The room where fire occurred is occupied for the breaking of the pyroxylin cakes by cracker rolls. These rolls consist of composition cylinders with irregular teeth which pass through the teeth of a stationary blade. The cake is pressed by hand against the stationary blade, and as the cylinder revolves the cake is broken up into small pieces. As the rolls are made with the view of preventing the generation of sparks from metal contact, it does not seem probable that fire originated from this cause. From the statement by assured it was inferred that the pyroxylin cake contained some foreign material. This theory has not been substantiated however, and the real cause of fire is not known.

From statements of eye witnesses, the sprinklers controlled fire very easily, in fact the control was such as to prevent the igniting of several barrels of stock which were in the room. The main damage was the charring of the room woodwork, with a small water damage to the color presses in the basement below.

6236. Philadelphia, Pa. August 19, 1907. Cotton Mill. Assured formerly handled stock from floor of picker house, after passing through mixing picker, to a fan in picker house which delivered stock through metal pipe to stock boxes in card room in main mill. This method of handling stock in picker house proved too slow, and a little under a year ago pipe leading to fan was connected direct to mixing picker, so that stock now blows direct from picker through fan to card room, without handling.

It is supposed that some foreign substance struck fire in the mixing picker and smoldering stock was blown over into stock box in card room. Mill had started up at 6.30 a. m. and a fair grade of linters with a small percentage of pickings was being worked. This stock had been blown over into one of the largest stock boxes in card room (4 by 16 feet and the height of ceiling), and it is supposed fire

smoldered until there was considerable smoke in stock box, although none was noticed out in room, box being closed.

The first intimation hands had of any fire was when a heavy explosion occurred in the stock box, and about seven feet of the side wall was blown out, followed by a dense black smoke which drove them away from this end of room. Explosion was undoubtedly due to smoke.

There were two sprinkler heads in stock box, and these, with 20 others in room, opened promptly and almost extinguished fire.

6223. Shadyside, N. J. August 30, 1907. Corn Product Factory. This fire took place during a regular reinspection of the plant. The meal cake consists of hard, dry, thin cakes from the oil filter presses. (Corn oil is pressed from the germs of the corn.) The cakes are broken up in a mill located in the room where fire occurred, then elevated to the second floor and ground in three high speed mills driven by three induction motors. The finely ground meal is dropped through a wood chute into a wood hopper on the first floor, to the bottom of which bags are fastened, and the meal bagged. The open top of the hopper is enclosed with thin cheese cloth. The fire started in the hopper and very suddenly burst out through the cheese cloth, scorching the employee who was bagging the meal. The loose dust around the room and on the ceiling made a quick flash fire that promptly put eight sprinklers in operation.

The fire marshal was on hand and opened steam jets in the elevator legs and in the conveyor leading from second floor into feed house adjoining, so that if there was any tendency for the fire to spread through this apparatus it was quite promptly headed off. A small blaze was noticed on top the conveyor, second floor, which was put out by a pail of water.

6234. Stoughton, Mass. September 5, 1907. Shoe Factory. At time of fire factory was shut down because of electric power and lights giving out. Viscolizing of soles was being done in basement. One of the men lighted a lantern and placed it near tanks. There were three barrels of viscol in two tanks 2x2x5 feet, both were full of soles. The naphtha with which the viscol was thinned took fire with a slight explosion. As the tanks were open there was no confinement of the fumes and no scattering of the liquid. The joists directly over the tanks show no sign of fire and the only burning appears to have been on a box near to and above one of the tanks and on the soles themselves. It was more in the nature of a slight puff than an explosion with the burning confined to the viscol tanks and contents. Two sprinklers in the bay directly overhead opened and held fire in check while employees extinguished it with dry powder chemical extinguishers. It was found impossible to replace covers.

The water from the sprinklers flowed the burning viscol about the floor to some extent, but the employees aided by the automatic sprinklers were able to extinguish the blaze with remarkably little damage.

Viscol as sent to factories always contains naphtha and the assured usually add more naphtha to it as necessary. This work should always be done outside the building, and assured while now

having work done in another factory have agreed if they commenced doing it again to build a special house for the purpose outside the building.

6231. Maine. September 29, 1907. Paper Mill. At the time above mentioned, water was discovered running from the sprinkler system in the lime storage room. It was promptly shut off at valve located in digester room. Investigation revealed a broken tee in feeder near ceiling in lime room. The sprinklers in this room have been disconnected for some time, but the feeder remains, passing through the room to supply heads in the sulphur storage rooms adjoining. The water discharged from this broken tee was sufficient to slack a large amount of lime (estimated at three carloads or 90 tons) and generating heat enough in the mass to set fire to the floor and bins at at least six observed places. At one place, the fire worked through the floor, and threatened the sulphur underneath. By keeping the underside of floor dampened, however, the fire was held in check.

The increase in bulk of the slacked lime was sufficiently powerful to push out or bulge the 12-inch brick walls on two sides of room, so much that the larger part of them will have to be rebuilt.

6235. Butler, Pa. October 6, 1907. Foundry. An explosion occurred in the main building of this risk at about 8.30 p. m., doing considerable damage and causing a small fire. Plant was in operation and it is thought that explosion was caused by the overturning of a "bull" ladle, holding several tons of melted iron, into a pool of water. Melted iron was thrown to all parts of the main building, and the roof, immediately above, was ignited. The force of the explosion was sufficient to break all the windows of the main building and in some instances the window frames themselves were broken.

This risk is being equipped with Grinnell glass disc sprinklers; the only portions not yet equipped being the cleaning rooms. Seven of the eight dry valves and piping and sprinklers on same had been installed. Risers are supplied by a 6-inch yard loop and controlled outside by post indicator gates. These systems were being tested for leaks and water was on all systems; the gates being partly closed, however.

The gate in the 6-inch connection from the 12-inch city main and the P. I. V.'s were opened immediately after the explosion. Until the former was opened, the only supply was through a 4-inch connection from the city main and a 2-inch by-pass around the gate valve.

About 325 of the 360 sprinklers in the building were opened; they being supplied by two 6-inch risers through two Grinnell dry valves. Most of the sprinklers were probably opened by a hot blast from the explosion as the only indications of a fire were right over the place where the explosion occurred; a monitor and a small part of the roof being destroyed. Was told by man who was in risk at the time that the sprinkler system worked well and apparently held the fire in check. The local fire department responded to whistle call and, in all, used 4 or 5 streams on fire which was extinguished easily. The supply to the sprinklers was shut off as soon as the fire department arrived.

About 42 men were severely injured; four of whom died soon after the explosion.

6232. Rensselaer, N. Y. October 22, 1907. Color Works. Fire was due to carelessness of employee who allowed a kettle of dyes to overflow. The kettle contained a mixture of aniline oil, nitro-benzole and an aniline salt. The kettle is heated by coal. The door through which they "fire" was open at the time the kettle overflowed and the mixture flowed into it, causing a flash fire. All the sprinklers in the room opened. A few gallons of water were used from the house tank, but the 750 gallon pump was immediately started and fire was extinguished with 60 sprinklers and three hose streams from assured's hydrants, all supplied by the pump. The fire department was notified by telephone, but the fire was out by the time they arrived. A 2½-inch tin clad fire door protects the opening between the north and south sections of this building, and prevented the fire from entering the south section.

SPECIAL HAZARD FIRES.

H-1960. Starch Factory. Regarding the recent explosion in the cyclone and dust collector the following explanation and theory is advanced. The dry starch (Edible corn-starch, $C_6 H_{10} O_5$) after coming from the dry kilns is broken up and spread on wooden trays and then in turn is emptied by hand into a metal hopper and blown from the first floor of the dry starch building to the grinder on top of the packing building. The starch in passing from one building to the other is blown by a fan running at 930 revolutions per minute through 150 feet of galvanized pipe inclined at an angle of 45 degrees into a galvanized iron cyclone vented to a metal dust collector, which in turn is vented through a galvanized iron pipe back to the fan, the starch dropping by gravity from the cyclone through a wooden spout into a wooden hopper over the grinders. The conveyor pipes and cyclone are covered with felt and canvas to prevent the warm dry starch from becoming moist due to condensation in cold weather.

The starch in passing through the metal conveyor pipe at this high rate of speed probably becomes electrified and under certain conditions of humidity and suspended starch dust an electric spark is produced, which ignites the starch dust in the cyclone producing an explosion.

Under ordinary conditions the static electricity is discharged to the earth through a sprinkler pipe fastened to the metal lining of the dust collector.

The explosion expanded into the dust collector, wrecking both cyclone and dust chamber and flashing back through the conveyor pipe, scorching the starch in the hopper. The sudden reaction of this expansion produced a vacuum in the conveyor pipes, causing their collapse.

Since the last explosion the following changes have been made: The cyclone has been increased in height; four vents provided with loose fitting caps have been made in top of cyclone; five similar vents have been provided in roof of dust collector. In this way it is hoped to lessen the force of future explosions.

The conveyor in the dry starch building has been grounded to the sprinkler piping by a heavy copper wire.

The covering has been removed from the vent pipe connecting the dust collector with blower in dry starch building.

By the above changes the assured hope to eliminate the cause and condition producing the explosion.

S-6229. Paint Factory. Fire broke out inside a corrugated iron dryer 30x5½x6 feet in which a chrome green pigment, made from Prussian blue and chrome yellow, was drying. Dryer is heated by steam at one end and air is drawn to other end by a fan. The color is spread while moist onto a cloth-top frame in about two-inch layers. These frames are piled on trucks and run into dryers. Dryer contained six full trucks and one empty one, about 300 racks of stock. Fire started in end near steam pipes (although superintendent says heat is never over 140°) and spread through dryer, also partially into another dryer. Superintendent had just been trying steam pump and steam was up and pump primed. Fire was fought and controlled by two hose streams and was most out when apparatus arrived. The loss was confined to contents alone.

Loss not yet adjusted but will be under $1,000.

A fire very similar to this occurred in New York in a paint factory manufacturing the same kind of color, i. e., chrome green from Prussian blue and chrome yellow. Prussian blue, or ferricferrocyanide: Fe_4 $(Fe\ (C\ N)_6)_3$ contains about 24% of carbon and chrome yellow, or chromate of lead $Pb\ Cr\ O_4$ contains about 20% of oxygen. These ingredients are mixed wet, then dried as described above and finally ground. Temperature of oven never goes above 140° and there is nothing of an inflammable nature that enters into mixture. It is possible that bits of filter cloth might char and become ignited from some liberated oxygen from the lead chromate. This latter substance is a well-known oxidizer and will heat and ignite spontaneously in the presence of oils, etc. There may be certain conditions in which the carbon of one is acted upon by the oxygen of the ingredient, resulting in combustion.

The superintendent at works, a trained chemist and experienced in paint manufacturing, states that he is baffled but is much interested and would like to discover an explanation.

MISCELLANEOUS FIRE RECORD.

H-1964. Nashville, Tenn., 1907. Mercantile Risk. Some months ago a notable fire occurred at Nashville, Tenn., in a mercantile building of hollow concrete block construction, and the occurrence has been given more or less publicity in an advertising way.

The building has been inspected by members of the Committee on Concrete and Re-Inforced Concrete for Building Construction who submit the following:

The building, as shown on the accompanying illustration, is about 50x170 feet, four stories high, built of two-piece concrete blocks, apparently of good ordinary quality. It was occupied throughout as a retail furniture and house furnishing store, the upper floor being used for the storage and salesroom for certain grades of furniture. Over this top story was a suspended lath and plaster ceiling, and above this a blind attic three to five feet high. The roof was of ordinary joist construction,

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as were the various floors, and this attic was said to be unoccupied and free from combustible material, except the construction members.

The fire apparently started in this attic in the vicinity of the elevator sheaves and spread throughout this space, burning off the roof of the suspended ceiling and also burning out most of the contents of the top story, but did not entirely burn the floor, nor did it extend to any of the stories below.

It is quite apparent that the heat in the top story was severe for a limited period, especially against the concrete blocks forming the top of the walls above the suspended ceiling.

The result was the chipping and spalling of window lintels and sills to a considerable extent and the destruction of a galvanized iron cornice,

but so far as could be ascertained there were no serious fractures in the walls or their individual blocks.

As a precautionary measure the Building Department insisted upon the erection of a number of re-inforcing pilasters around the inside of the building, and after this was done the roof and suspended ceiling were replaced in practically the same manner as before. The sills and lintels of the windows were patched up with cement at the point where the worst damage occurred, and as the building stands today it shows hardly any trace of the fire.

Taken as a whole, the test, while not nearly as severe as would have been had the fire started lower down, was very creditable to the blocks as installed.

H-1963. Philadelphia, Pa. October 31, 1907. Tobacco Factory. This building is of four stories with a front of 35 feet and 200 feet in depth. First floor and cellar are occupied by jobbers in tobacco and cigars; second, third, and fourth floors as a shirtwaist factory.

The fire was discovered by a policeman, who saw smoke issuing from around the door jambs and gave the alarm promptly. Upon arrival of the firemen, the doors were broken open, which act was followed by a low explosion which forced out the large plate glass windows and instantly ignited the whole interior of the first floor. The fire on this floor being readily accessible was soon extinguished and revealed a fire coming up through the floor from the cellar, where a fire was found burning along the ceiling and was soon controlled. At the beginning of the fire the firemen and patrolmen went to the second and third floors, but found no fire, only the presence of smoke. Suddenly a report of a low explosion was heard from above, attended with an ignition of the interior of the upper floor, this was followed by a falling of the side walls down into an area way at side of building, and before the fire on the top floor was extinguished the entire contents and roof were destroyed, leaving only a portion of the rear wall of the top floor standing. The communicating of the fire from the first floor to the fourth was apparently a mystery, as the elevator shafts at each end of the building were provided with doors which were closed and not touched by the fire, but afforded a draught around the edges of the doors for smoke which ascended to the top floor, filling that portion of the building. It was finally discovered that the fire on the first floor had extended out of a window looking out to a side alley and ignited the window frames on the second and third floors; but these windows being boarded up on the inside offered some resistance to the fire, but the window on the top floor being exposed and thrown out by the explosion, it was concluded that the fire had been communicated to the top floor by the burning of the frame and breaking of the glass. It is also believed that the sudden ignition of the upper story resulted from a thick accumulation of smoke and its ignition by the breaking away of a skylight on the roof, which afforded the vent and drawing up of the required amount of oxygen to form the explosive mixture. As the smoke from the fire on the first floor was largely given off from the burning of loose tobacco, and the low explosion being attended with some force, it must have removed any doubts as to the explosive character of tobacco smoke. As the only part of the flooring on the first floor burned through was

directly over a heater just put in use, it was found that the smoke pipe, which was directed to the chimney through a lath and plaster finish to the wall, was not securely entered and set fire to the lathing and from this to some empty cases against the wall close to the heater, thus spreading the fire among the stock.

Loss on building, $14,500.

Loss on contents, tobacco stock, $65,000.

Loss on shirt factory, $20,000.

H-1962. North Newport, N. H. November 20, 1907. Bobbin Factory. Fire occurred at 11.45 p. m. Risk was occupied as a bobbin factory and was comparatively a new building. Area about 3,200 square feet. Fire was discovered by the watchman and was fought with hose streams.

General Type or System of Construction. Mostly a brick building, 16-inch walls; plank on concrete floors and four-inch concrete roof reinforced with expanded metal and one-half-inch round rods two-thirds-feet apart. This was supported by eight by four-inch I beams, nine-foot bays over boiler, engine house, pump house, sawing building (in good condition but did not receive the greatest heat) and by steel truss (unprotected), 40-foot span, eight-foot bays over main building (completely destroyed; this received the greatest heat). No insulation of columns, girders and beams. Wood flooring in places. Roof covering, tar paper. Open finish of outside walls.

Remarks.—Had this main roof been supported by reinforced concrete beams with a moderate span (not over 16-18 feet) or even if supported by eight-inch I beams unprotected (not over nine-foot span), the inspector does not believe that roof would have fallen. It was unfortunate that the greatest heat of the fire was received by roof of main mill, which was least able to stand it. The concrete roof over boiler house which received the next heaviest heat shows no weakening. Temperature here must have been at least 2000° F. for 15-20 minutes. Temperature over engine room was not very high, probably not over 500°. Roof is partly cracked over engine room near main building, due to falling of main roof and consequent tearing and cutting of expanded metal on edge of brick wall. The roof of main factory is down, the concrete is cracked in many places and broken into pieces 10 or 20 feet square.

H-1965. Providence, R. I. December 10, 1907. Office Building. Discovered by janitor's assistant. Private box in building. Steam pipes run between wood floors and plaster ceiling in space between two floor joists. Plaster between upper and under floor. Apparently fire caused by collection of dust on steam pipes.

Fire burned joists on both sides of steam pipes, ran up partitions part way to second story and put out with loss of less than $1,000, and most of that from firemen cutting holes, and water. As the two upper stories are in a French roof of the most inflammable construction, full of voids between plastered partitions inside of roof and the slate covered roof boards, with no cut-offs, therefore there was an unobstructed raceway for fire about 800 feet long and 25 feet high opening into space above sixth story ceiling under roof of about 20,000 square feet.

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Notes and Tables.

CORN WHISKEY DISTILLERY.

The following is a description of the hazards and processes of a typical risk of this character, located near Atlanta, Ga.—Ed.

Processes.—The principal steps in the manufacture of corn whiskey in risk under consideration are the making of malt (for fermentation), grinding of corn, cooking and mashing of meal and malt, fermentation of "wort" and distillation of "beer", decidedly the most hazardous of processes being the latter.

Making of Malt.—Corn is used principally with small quantities of rye and barley, the assured claiming that additions of the latter two agents serve to give the whiskey a better flavor than it would have otherwise. The dirt, dust, and dead and broken seed are first removed by a revolving perforated iron drum separator on second story of Mill Building, after which the seed are steeped in a vessel of water in Fermentation Room for two or three days at a temperature at about 12° "C." It is stirred frequently, which brings the dead kernels to the top, so same can be removed. During the steeping the water extracts considerable soluble matter, oil, etc., from the grain. The grain increases in size about 25% in volume and about 50% in weight, and when a test of a few kernels indicates they are soft, the grain is "couched" by piling in a nice level heap on the cement flooring. A good circulation of air is absolutely necessary for the germination. The grain is sprinklered with water occasionally to insure a moist air, which is also essential. The temperature is kept as constant as possible in the early stages of process. After a few hours the temperature begins to rise within the "couch," and as the grain heats it becomes moist on the surface ("sweats") and evolves an agreeable odor. At this stage it can be noticed that the germination has begun, owing to the appearance of rootlets. The time for "couching" varies from 20 to 30 hours, according to condition of atmosphere, temperature, etc. No hazard of note considered involved in "couching." After "couching" the grain is taken to second floor of Distilling Building, known as Dry Room, and the grain is spread out on the heavy plank floor. The Dry Room is directly over still furnace, so the temperature is quite constant and warm. The grain is thus gradually dried. It is now termed malt and is ready for grinding and mixing with corn meal and hot water in the cooker or mash tun apparatus.

Grinding of Corn.—The principal raw stock corn is received by wagon and rail and elevated to second floor of Mill Building for storage. It is here thoroughly cleaned through the agency of revolving drum separator, after which it is spouted to corn mill on first floor, where the grain is ground into corn meal. Meal stored in Meal House for purpose. No very hazardous or unusual features connected with grinding process. Management claims shaftings and bearings are regularly cared for.

Cooking and Mashing.—After grinding into a meal of the corn

and the malt, they are mixed in such proportion that the fermenting power of the latter is fully sufficient to convert all of the starch of the former into sugar (intermediate product), and then into alcohol. In the ordinary distillery yeast is used for the fermentation of sugar into alcohol, but this plant differs radically from the usual process in adopting the "grandfather" idea. Water is next added and the whole allowed to flow into the cooking or mash tun apparatus. This machine is cylindrical in shape and is made of heavy cast-iron. The interior is fitted with fixed steam pipes, and stirrers connected to outside shafting. Management claims temperature is not allowed to rise above 140° F., owing to the fact that fermentation would set in, which is not desired at this stage. The mashing is simply a mechanical process, by means of which the starch is reduced to a form of paste, or it may be considered a preliminary process to form a ripe condition for the fermentation process to follow.

Fermentation.—Fermentation is a general term applied to certain chemical changes caused by the action of substances called ferments. There are two classes—(a) unorganized chemical substances or enzymes, and (b) organized bodies or living organisms. A ferment distaste of (a) classification is the ferment in malt used to convert starch of corn into sugar (intermediate product) and the sugar into alcohol. Under proper conditions ferments propagate with great rapidity. The temperature must be constant (about 30° C.) and an abundance of fresh air must be present, for the oxygen of the air enters into the reaction. From the cooking machine or mash tun apparatus the mash is run into the fermentation vats, which are of cement construction; top of tanks nearly on level with floor line. There are six tanks of about 1,800 gallons capacity each; tanks are used alternately in sets of three. The fermentation process lasts for 72 hours, after which the "beer" formed is pumped to six wooden tanks (about 250 gallons each) set over furnace in Distillery for charging stills. No attempt is made to collect carbon dioxide gas issuing from fermentation vats caused by the oxidation process involved; the gas is allowed to escape into the air. No hazard connected with the fermentation process, and since the beer formed after fermentation contains only about 10% of alcohol, the solution in charging tanks over furnace is not thought very dangerous.

Distilling.—The distilling process of any distillery is decidedly the most hazardous feature connected with the plant. The object of distillation is to separate the alcohol which has been formed from the non-volatile substances with which it is mixed. Accordingly, from the wooden charging tanks the "beer" is allowed to flow into the copper stills (six in number of 250 gallons capacity each) set in brick furnace. There is a distance of about 7½ feet from brick covering of furnace to heavy plank floor above. Wood is used for fuel; metal flue from furnace vents to brick chimney on outside, built from ground up. A large metal flue runs from ceiling of Furnace Room through Dry Room above, and vents through roof to outside. This vent serves to effect only a moderate heat in Dry Room, and relieves otherwise intense heat in Distillery proper. The distillation is allowed to proceed until all the alcohol has been driven off. The residue from stills is used for stock feed, and is poured into troughs running to cattle pen. The first distillate after condensation is termed "low wine" and contains about 20% alcohol; it flows from condenser through specific gravity testing apparatus (controlled by the government) to en-

closed metal tank of about 250 gallons capacity just beyond testing apparatus, on earth floor. As the solution in "low wine" tank contains only 20% of alcohol, the hazard here is not thought serious, considering earth floor first and heavy plank floor second about 12 feet above tank. From the "low wine" tank, the solution is pumped to a doubler, which is a copper still set in a brick furnace and fired from the outside, used for the re-distillation of solution, and thereby a concentration of the alcohol. From the condenser of the doubler the distillate, containing about 55% alcohol, flows by gravity to a charcoal filter, where the raw whiskey is filtered, and then run into interior charred whiskey barrels in Cistern Room through small piping. Only three barrels can be used at a time in Cistern Room. The Cistern Room is well cut off from the Distillery by a blank 17-inch wall. From the Cistern Room the barrels of whiskey are taken to the Bonded Warehouses, where they are stored for ageing. As the whiskey ages it absorbs coloring matter from the oak barrels, in which it is stored, thus imparting to the otherwise colorless whiskey a varied color, depending on the time allowed for storage.

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The South-Eastern Tariff Association.

MIRROR WORKS.

Process in General.—Plate glass packed with straw and excelsior received in Raw Stock Storage Room; here it is unpacked and glass is racked on wooden carts and transferred to manufacturing department.

The processes in manufacturing department are chiefly those of glass cutting, beveling, grinding, polishing and silvering. Of these processes, the second and third mentioned are carried on in wet state. The polishing process consists of pressing the glass against a revolving felt wheel, the mechanism analagous to emery wheel stands. The silvering process is generally done in a separate room. The silvering solution is made by dissolving silver nitrate crystals in water, and adding ammonia and rochelle salt. The polished pieces of plate glass to be silvered are arranged on warming tables (heated by steam pipes in the open on metal hangers) and the solution of silver salt poured on same. Under influence of heat the ammonia evaporates, leaving the reduced silvering compound forming the mirror background. After this compound has hardened and dried, the backs of the mirrors are painted and shellaced, and then are placed in racks and carried to Finished Stock Storage Room where mirrors are packed in excelsior, hay or straw, boxed and shipped.

Conclusions as Regards Hazards.—From the above it is readily seen the processes are simple, with special hazards pertaining, with few exceptions mild. Excepting common hazards of power, heat and light, hazards in general are as follows: Storage of excelsior, hay or straw for packing, arrangement of steam pipes of warming tables, painting and shellacing (methyl alcohol is used as a solvent for shellac), storage of inflammable oils.

NOTE.—Silvering solution non-hazardous, also its component solutions.

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THE DOMESTIC COTTON BALE.

Consequent upon the interest excited by the recent prominence given to the discussion of the subject of handling our cotton crop, it may be of value to observe the object lesson illustrated by the following photographs.

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An Interesting Contrast.

The small bale in foreground was *compressed* at the ginnery and has a density of about 26 pounds to the cubic foot, slightly in excess of the theoretical common carrier demand. It weighs 477 pounds and measures 22x25x57 inches. Note compactness and retention of shape. Given a better covering it would be a perfect bale. Salvage after a fire would be not less than 80%, as it is impossible for fire to "burrow" in bales of this type, there being an entire absence of air channels, as in ordinary compressed bales, due to the uniform, gradual and compact compression. Density is secured and held with several hundred per cent. less pressure than is the case with the ordinary bale.

The larger bale immediately behind foregoing is of the improved box-pressed type common to the modern system gin, the cotton passing through a condenser before entering box of press forming it into layers or bats. Density of this bale is about 14 pounds to the cubic foot, weighs 500 pounds and measures 25x42x57 inches. It is generally known as the Country Bale and the shape it is in gives a good idea of the average maximum good condition of these bales as received at town warehouses from the farmer prior to compression for shipment on final journey.

In the background is a bale common to the old-style gins in which the cotton is dropped into box of presses in lumps, not passing through condenser. It has a density of 12 pounds to the cubic foot, weighs 562 pounds and measures (approximately) 30x45x60 inches. Note difference between it and system gin bale immediately in front of it.

An Ordinary Condition.

This is a lump-pressed bale. A hoop has burst, usually the fault of the buckle, allowing cotton to spread, and this frequently occurs.

Another Contrast.

The bale in foreground on dray is a bat-pressed system gin bale, that on top back of it, a lump-pressed old-style gin bale and the one underneath has been pressed in an old-fashioned hand press. Note size of latter as compared to other two.

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